

TRANSITIONING INTO MATHEMATICS CURRICULUM LEADERSHIP:
A STUDY OF HOW A GRADUATE DEGREE PROGRAM
INFLUENCED LEADERS' VIEWS, ACTIONS, AND RESPONSES

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Doctor of Philosophy

By

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The undersigned, appointed by the Dean of the Graduate School, have examined the dissertation entitled

TRANSITIONING INTO MATHEMATICS CURRICULUM LEADERSHIP:
A STUDY OF HOW A GRADUATE DEGREE PROGRAM
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DEDICATION PAGE

This dissertation is dedicated to my two inspirations: (1) My beloved mother, *Ms. Mildred Cummings*, whose loving spirit sustains me still and (2) My loving son, *Antoine Allen Turner*, who gives me joy and meaning to love.

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I end with the following poem of encouragement that has been my inspiration since being introduced to it:

Don't Quit

When things go wrong, as they sometimes will,
When the road you're trudging seems all uphill,
When the funds are low and the debts are high,

And you want to smile, but you have to sigh,
When care is pressing you down a bit,
Rest, if you must, but don't you quit.
Life is queer with its twists and turns,
As every one of us sometimes learns,
And many a failure turns about,
When he might have won had he stuck it out;
Don't give up though the pace seems slow--
You may succeed with another blow.
Often the goal is nearer than,
It seems to a faint and faltering man,
Often the struggler has given up,
When he might have captured the victor's cup,
And he learned too late when the night slipped down,
How close he was to the golden crown.
Success is failure turned inside out--
The silver tint of the clouds of doubt,
And you never can tell how close you are,
It may be near when it seems so far,
So stick to the fight when you're hardest hit--
It's when things seem worst that you must not quit.

~ Author unknown

ABSTRACT

The purpose of this *intrinsic multi-descriptive* case study was to explore how a mathematics curriculum leadership graduate degree program influenced seven participants' views and actions as they transitioned into new mathematics curriculum leadership roles. The mathematics curriculum leadership graduate degree program was a joint partnership between a mid-western school district and a university. The graduate program was designed to support the development of knowledge and competencies related to K-12 mathematics curriculum design, analysis, implementation, and evaluation as well as leadership.

Data sources included interviews with the participants in 2005, 2008, and 2011. In addition, the participants wrote journals and responded to writing prompts throughout the three years of the program. Results revealed the mathematics curriculum leadership graduate degree program facilitated the development of specialized knowledge about mathematics curriculum and leadership. The mathematics curriculum leaders changed their views of leadership, how they perceived themselves as leaders, and how they perceived their colleagues' views of them. The mathematics curriculum leaders assumed new leadership roles and responsibilities and the program influenced how they approached situations that required leadership (e.g., conflict and communication with colleagues) as well as challenges. Based on the unique design of the graduate degree program, the mathematics curriculum leaders drew on the support from other participants in the program.

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LIST OF ABBREVIATIONS

AMTE – Association of Mathematics Teacher Educators

AP – Advance Placement

APA – American Psychological Association

ASSM – Association of State Supervisors of Mathematics

CLLC – Center for Leadership and Learning Communities

EDC – Education Development Center

ERIC – Educational Resource Information Center

ESL – Elementary School Journal

GLE – Grade Level Expectation

JMTE – Journal of Mathematics Teacher Education

JRME – Journal for Research in Mathematics Education

K/KG – Kindergarten

MCL – Mathematics Curriculum Leader

MCTM – Missouri Council of Teachers of Mathematics

M.Ed. – Master of Education

NCLB – No Child Left Behind

NCSM – National Council of Supervisors of Mathematics

NCTM – National Council of Teachers of Mathematics

NRC – National Research Council

PD – Professional development

PTA – Parent Teacher Association

TLI – Teacher Leader Institute

Chapter 1: Introduction

The National Council of Teachers of Mathematics' (NCTM) *Principles and Standards for School Mathematics* (2000) describes a vision in which all students have access to rigorous, high-quality mathematics instruction. Unfortunately, this vision is not the reality in many mathematics classrooms today. NCTM has raised certain questions in its pursuit of realizing this vision. The questions being, "How can all students have access to high-quality mathematics education?" (p. 368) and "How can teachers learn what they need to know?" (p. 370). Successfully addressing these questions will require well-designed mathematics curricular resources and teachers who are well equipped to use them. Therefore, schools must establish effective structures that support students' mathematical learning and teachers' professional growth. For example, schools need strong leaders who can facilitate school improvement efforts and support other teachers to improve their teaching so that ultimately, students are more successful learning mathematics.

Historically, leadership and more specifically, mathematics curriculum leadership has been in the hands of a few administrators such as school board members, principals, department heads, and/or curriculum specialists (Barth, 2001; Even, 1999; Gehrke, 1991; York-Barr & Duke, 2004). However, within the past twenty years, the realm of leadership has expanded beyond administrators to include teachers. This movement has been encouraged by calls for school improvement and systemic change, which suggests that curriculum leaders are critical to effective schools (Fullan, 2001b) and successful curricular innovations (Boyd-Dimock & McGhee, 1995). For example, Sikes (1992) argues that teacher leaders are a force for transforming teaching practices because they

can provide support mechanisms at the school level. Nevertheless, in recent years, curriculum leaders who assume responsibilities outside of their classrooms have grown in prominence throughout schools in the United States.

Mathematics curriculum leaders assume a variety of roles such as facilitating professional development, writing assessments, reviewing and monitoring curriculum policies, selecting curriculum materials, mentoring novice teachers, coaching their peers, and assisting with school-level decision making (Chval et al., 2010; Halai, 1998; Li, 2004). Some leaders perform these roles while they are full-time teachers, while others perform them in positions with titles such as mathematics curriculum coordinators, mathematics coaches, or mathematics specialists. These roles require specialized knowledge and competencies (Chval et al., 2010). However, districts and schools do not always possess the appropriate infrastructure to prepare and support the acquisition of this specialized knowledge. Consequently, mathematics curriculum leaders pursue professional development opportunities through professional literature, conferences, or university degree programs. For example, the National Council of Supervisors of Mathematics (NCSM) created an annual summer leadership academy to prepare mathematics curriculum leaders and the Center for Leadership and Learning Communities (CLLC) at the Education Development Center (EDC) offers leadership-training institutes for leaders in school-based settings. Although these are well-respected programs, a relatively small number of mathematics teachers are in attendance due to finances, distance, and time. Additionally, there is an insufficient number of professional development opportunities directly related to mathematics curriculum leadership available to mathematics teachers in our nations' schools. Therefore, more professional

development opportunities are needed to provide the specialized knowledge to develop as a mathematics curriculum leader.

As teachers are taking on the role of mathematics curriculum leadership, little is known about their transition from experienced teacher to novice leader. How do the leaders apply what they learn from professional development opportunities and programs in their school settings? Research related to these important issues could inform the design of professional development academies/institutes or graduate programs that help teachers develop specific knowledge bases and competencies related to mathematics curriculum leadership.

Purpose of the Study and Research Question

The purpose of this study is to understand the transition of classroom teachers to mathematics curriculum leaders and how a particular mathematics curriculum leadership graduate degree program influenced this transition. As such, the following research question guided this study:

How did participation in a mathematics curriculum leadership graduate degree program influence participants' views about leadership, leadership roles they assumed, and their actions in relation to these leadership roles?

Definitions and Conceptualizations of Teacher and Curriculum Leadership

Research related to mathematics curriculum leadership is limited; however, there are more established literature bases related to broader categories (i.e., curriculum leadership, teacher leadership). Consequently, the more general literature bases of teacher leadership and curriculum leadership were employed to inform the design of this study as illustrated in *Figure 1*.

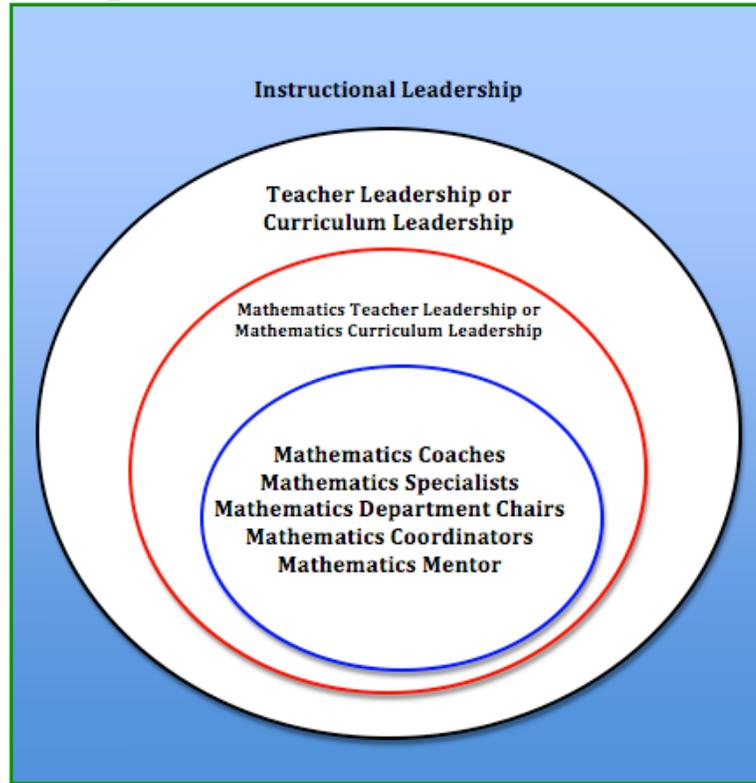


Figure 1. Literature bases that inform research on mathematics curriculum leadership.

In the following sections, interpretations of teacher and curriculum leadership are presented. Accordingly, the discussion begins with how teacher leadership is defined and conceptualized in the literature. Definitions used to explain curriculum leadership will follow. The chapter concludes with a description of why this study is significant.

Teacher leadership.

The term *teacher leadership* is often discussed, both formally, as in the literature for practitioners and in professional conferences, and informally, in schools and other places (e.g., social gatherings). However, the definition of teacher leadership is rarely explicit or consistently defined (York-Barr & Duke, 2004; Wasley, 1991). York-Barr and Duke state, “Teacher leadership is an umbrella term that includes a wide variety of work at multiple levels in educational systems, including work with students, colleagues, and

administrators and work that is focused on instructional, professional, and organizational development” (p. 288). Nevertheless, reports have emphasized the need for teachers to extend their influence beyond the classroom and into school-wide leadership activities so that they are viewed as both teachers and leaders (Boyd-Dimock & McGhee, 1995; York-Barr & Duke, 2004).

Wasley (1991) considers teacher leadership problematic. In her study of understanding teacher leadership, Wasley solicited the assistance of teachers, teacher leaders, and administrators to identify a definition of teacher leader. These individuals were able to identify roles and/or responsibilities of a teacher leader, but they were not able to precisely define the term. In responding to a question related to how participants would define leadership, administrators stated that teacher leaders and administrators had shared leadership or empowerment. On the other hand, teachers and teacher leaders consistently asked for clarification about what the researcher meant by the question. When Wasley provided further explanations or examples, participants replied with vague responses. Participants did not have an understanding of how teacher leadership was defined. Furthermore, the definition of teacher leader was not perceived as important or worthy of faculty discussions. Eventually, the participants described teacher leaders as “people who had the ability to share information and to influence others in matters related to curriculum and instruction. Leaders had the ability to go beyond the classroom to be current in research, and to be teaching advocates” (p. 2).

Other attempts at defining the term teacher leader resulted in describing necessary roles or responsibilities that these individuals assume. In particular, Barth (2001) describes teacher leadership as being essential to the health of a school for choosing

textbooks and instructional materials, shaping curriculum, setting standards for student behavior, deciding whether students are tracked into special classes, designing staff development and in-service programs, setting promotion and retention policies, deciding school budgets, evaluating teacher performance, and selecting new teachers and administrators. This list of responsibilities was representative of other definitions for teacher leader (Lieberman, Miles, & Saxl, 1988; York-Barr & Duke, 2004). In Boyd-Dimock and McGhee's (1995) study, administrators, teacher leaders, and teachers described teacher leaders as teachers who were not necessarily vested in the traditional definitions of leadership as "higher" or "superior" positions within the organizational hierarchy. Instead, teacher leadership was a collaborative effort, a "banding together" with other teachers to promote professional development, growth, and the improvement of educational services.

Conceptualization of teacher leadership.

Teacher leadership is a unique form of leadership that is legitimately grounded within the boundaries of leadership theories such as distributive leadership. Over time, researchers have conceptualized teacher leadership in different ways (e.g., see Crowther, Kaagen, Ferguson, & Hann 2002; Katzenmeyer & Moller, 2001; King, 2002; Silva, Gimbert, & Nolan, 2000). Three conceptualizations of teacher leadership are as follows: (1) a position of authority that is primarily administrative (e.g., curriculum coordinator, department chairs), (2) additional roles that are assigned to specific teachers so that they can support other teachers within their schools (e.g., mentors, coaches, professional development facilitators), and (3) an action that transforms teaching and learning across the entire school organization.

At one time, teacher leadership was conceptualized as a formal position for individuals such as department chairs who had authority over other teachers. Teacher leaders' roles included such tasks as setting clear goals, allocating resources to instruction, managing the curriculum, monitoring lesson plans, and evaluating teachers (King, 2002). Such a role was believed to be a pathway to administration.

Over time, school administrators began to take advantage of the instructional expertise of teachers by appointing them to roles such as curriculum leaders and mentor teachers. This led to a different conceptualization of teacher leadership in which the teacher leader held dual roles. From this perspective, teacher leaders are teachers who lead within and beyond the classroom, influence others toward improved educational practice, and identify with and contribute to a community of teacher leaders (Katzenmeyer & Moller, 2001). This conception of teacher leaders includes a much deeper involvement in teaching and learning. Teacher leaders are more involved with the professional development of teachers (King, 2002).

The conceptualization of teacher leadership has recently moved beyond capitalizing on teachers' instruction. A third conception of teacher leader recognizes that the organizational culture of schools should support collaboration and continuous learning and recognize teachers as primary creators of school culture (Silva et al., 2000). Crowther, Kaagen, Ferguson, and Hann (2002) describe this conceptualization of teacher leadership as:

An action that transforms teaching and learning in a school, that ties school and community together on behalf of learning, and that advances social sustainability and quality of life for a community.... Teacher leadership facilitates principled action to achieve whole-school success. It applies the distinctive power of teaching to shape meaning for children, youth and adults. And it contributes to long-term, enhanced quality of community life. (p. xvii)

Based on the preceding information, one can conclude that teacher leadership encompasses the entire school.

The three conceptualizations described above illustrate different perspectives on teacher leadership at the school level. For example, if a principal conceptualizes teacher leadership as the department chair with authority over others, then that conceptualization will influence leadership structures in place at that school. Conversely, if a principal expects teacher leadership to be distributed across the mathematics faculty members, then the role of leaders (e.g., to establish a professional learning community) will look very different from the first example. This suggests that when researchers study teacher leadership, they must determine how stakeholders in the school environment not only define teacher leadership, but also conceptualize it.

Curriculum leadership.

Teacher leaders have identified roles in school districts (Gehrke, 1991). They have accepted various position titles over the years such as department chairs and curriculum committee chairs. The term, *curriculum leadership*, signals a new focus for teacher leaders (Klein, 1985).

Researchers argue that leadership is critical to improving curriculum efforts. For example, Li (2004) suggests that “New leadership which looks for teacher collaboration and empowerment may hold the key for successful curriculum reform” (p. 2). Other researchers posit that curriculum leadership involves teachers who play a leadership role and operate in a different professional space from that of administrators (ECRA Group, 2010; Lord & Miller, 2000; McCombs, 2006; Silva et al., 2000). McCombs (2006) provides the following specific definition of curriculum leaders:

A curriculum leader refers to an individual who, by authority and/or skill, gives direction to or has managerial responsibility for curricular processes (curriculum alignment and/or classroom instruction) and implementation that will directly affect the instruction of teachers and the academic achievement of students.
(p. 10)

Curriculum leadership can yield significant benefits for the school system (Campbell & Malkus, 2011; Halai, 1998; Li, 2004; York-Barr & Duke, 2004). Curriculum leaders assist with school improvement efforts (e.g., shifting curricular responsibilities from administrators) that are vital for the achievement of high-quality school programs for all students (NCSM, 2000). They also have experience in teaching with a reputation of being successful and the potential to assist colleagues to improve their instruction (Bailey, 1990, Klein, 1985; Li, 2004; McCombs, 2006).

Significance of the Study

Mathematics curriculum leadership has the potential to impact student mathematical achievement through teacher professional development, professional accountability, and curriculum development (ECRA Group, 2010). Mathematics curriculum leaders can assist educators in improving their mathematical instructional practices and ensuring that student achievement improves as a result of meaningful, supportive decisions about mathematics pedagogy, coursework, and instruction. Chval (in press) states,

Recent calls for scientifically based research (NCLB, 2002; National Research Council [NRC], 2002), rigorous academic standards (NCLB, 2002), criteria for evaluating curricular effectiveness (NRC, 2004), researched-based curricula (Clements, 2007), mathematics curriculum materials that enhance student learning (Whitehurst, 2003), as well as public controversy (i.e., the math wars) over different curricular approaches have elevated the importance of examining how teachers enact mathematics curriculum materials in K-12 schools across multiple sites. (n.p.)

School districts have begun to consider how to strengthen teaching and learning through the support of mathematics curriculum leaders. Mathematics curriculum leaders have

assumed different positions such as coaches, specialists, department chairs, coordinators, and district professional development facilitators. Each position carries with it a variety of responsibilities. Some positions have been part of existing school administrative structures (e.g., mathematics curriculum coordinators and mathematics department chairs), while other positions (e.g., mathematics specialists and coaches) have been established in recent years. Currently, nine states have certification programs for elementary mathematics specialists (Association of Mathematics Teacher Educators, 2010, p. 2). These programs have led to increased interest in the preparation, support, practices, and impact of mathematics curriculum leaders. Although interest in mathematics curriculum leadership has expanded in recent years, at this point the research base related to mathematics curriculum leadership is limited as will be demonstrated in the following chapter. Due to the limited research, this study has the potential to make significant contributions to the field's understanding of the role and impact of curriculum/teacher leaders.

Increased attention on the use of mathematics curriculum leaders as a strategy for school improvement warrants a renewed focus on understanding the work they do as well as the challenges they face as they assume different roles and responsibilities along with knowledge bases and competencies. In addition, we need to understand how their participation in mathematics curriculum leadership programs influences their leadership views and actions. Understanding these needs will inform the design of future professional development and graduate programs focused on mathematics curriculum leadership. The findings generated from this study will also help mathematics teacher educators as well as school and district administrators better understand the transition into

curriculum leadership, thus placing them in a better position to support teachers' transition into curriculum leadership roles.

Chapter 2: Review of the Literature

This study seeks to describe mathematics curriculum leaders' views of leadership, the leadership roles they assumed in their educational communities, their actions in relation to these leadership roles, and the challenges they faced as they transitioned into these roles. Moreover, participants' perceptions related to how involvement in a mathematics curriculum leadership graduate degree program influenced their actions are reported. Therefore, a review of the research literature has informed and framed this study. This chapter includes a discussion of the major findings from a review of the research literature related to teacher leadership and curriculum leadership within and outside the field of mathematics education.

To facilitate the search for literature related to teacher and curriculum leadership, specific research journals (i.e., *Journal of Mathematics Teacher Education*, *Journal of Research in Mathematics Education*, *The Elementary School Journal*, *American Educational Research Journal*, *Review of Educational Research*, *Educational Leadership*) and the academic search engine, Educational Resource Information Center (ERIC), were utilized. For each of these sources, key words were employed to identify potential peer-reviewed, empirically based publications. For example, using the key term *teacher leadership* initially resulted in 222 publications. Upon further examination, articles that were not studies directly related to teacher leadership (e.g., an article that called for linking research to practice) were eliminated. *Table 1* specifies the key words used for each search by source. The terms *teacher leadership* and *curriculum leadership* were used to identify the prevalence of publications related to mathematics curriculum

leadership. In addition, publications specifically related to leaders’ transition into teacher and curriculum leadership narrowed the results.

Table 1

Research Publications Within The Specified Keyword(s) In Journals and The ERIC

Search Engine

	Keyword(s) searched								TOTAL Teacher/Curriculum Leadership Articles within the specified Journal/Search Engine	TOTAL Mathematics Teacher/Curriculum Leadership Articles within the specified Journal/Search Engine	
	“teacher leadership”	“curriculum leadership”	“mathematics” “teacher leadership”	“mathematics” “curriculum leadership”	“teacher leadership” “transition”	“curriculum leadership” “transition”	“mathematics” “teacher leadership” “transition”	“mathematics” “curriculum leadership” “transition”			
Sources searched	Journal of Mathematics Teacher Education - JMTE	4	0	3	0	1	0	1	0	4	3
	Journal for Research in Mathematics Education – JRME	0	0	0	0	0	0	0	0	0	0
	The Elementary School Journal – ESJ	10	2	1	1	2	2	1	1	11	1
	American Educational Research Journal	3	0	0	0	1	0	0	0	3	0
	Review of Educational Research Journal	2	0	0	0	2	0	0	0	2	0
	Educational Resource Information Center – ERIC	92	8	2	0	0	1	0	0	100	2
Research Results											

Overall, six peer-reviewed studies specifically related to leadership in mathematics were identified. Only one of the six studies involved both mathematics leadership and their transitions (see *Table 2*).

Table 2

Mathematics Teacher and Curriculum Leadership Peer-Reviewed Studies

Author	Title	Year	Source
Chval, K.B., Arbaugh, F., Van Garderen, D., Lannin, J.K., Cummings, L., DuChene, A., & Huey, M.	The Transition from Experienced Teacher to Novice Mathematics Coach	2010	The Elementary School Journal, 111(1), 191-216
Even, R.	The Development of Teacher Leaders and In-service Teacher Educators	1999	Journal of Mathematics Teacher Education, 2(1), 3-24
Gigante, N. A., & Firestone, W. A.	Administrative Support and Teacher leadership in Schools Implementing Reform	2008	Journal of Educational Administration, 46(3), 302-331 (via the ERIC search)
Halai, A.	Mentor, Mentee, and Mathematics: A Story of Professional Development.	1998	Journal of Mathematics Teacher Education, 1, 295-315
Mangin, M. M.	Facilitating Elementary Principals' Support for Instructional Teacher Leadership	2007	Educational Administration Quarterly, 43(3), 319-357 (via the ERIC search)
Nickerson, S. D., & Moriarity, G.	Professional Communities in the Context of Teachers' Professional lives: A case of Mathematics Specialists	2005	Journal of Mathematics Teacher Education, 8, 113-140

The data presented in *Table 1* demonstrate that although there has been significant research on teacher leadership in general, there has not been a great deal of research on curriculum leadership especially in the mathematics context. Moreover, very few studies have investigated the transition from teacher to mathematics curriculum leader.

Prior to reviewing individual studies about teacher and curriculum leadership, two research meta-analyses related to teacher leadership were identified (Hart, 1991; York-Barr & Duke, 2004). These syntheses helped identify how other researchers have organized similar reviews. A description of how these two reviews were arranged is presented below followed by an explanation of how this literature review is organized.

Hart (1991) focused her review of the literature on the concept of “leadership succession,” meaning different members of the school system move into other leadership or administrative positions. In some instances, a teacher may accept a position as assistant principal or a teacher leader may become the district curriculum coordinator. Hart’s review extended beyond teacher leadership to include principal leadership and other types of “leadership succession.” Hart argued that in many cases members of the school system apprentice into these new roles and have opportunities to observe how these roles function. For example, teachers have many opportunities to observe the roles and responsibilities of principals. Unlike these positions, teacher leaders often must create their own roles as they go along, leaving them both more unsettled and freer to be creative. Hart’s review was organized around “organizational socialization” in education and management in which four key themes were discussed: tactics employed by the organization, socialization stages through which new members pass, personal and social contexts which shape the process, and outcomes or effects. Hart’s work helps us understand the challenges associated with transitions into leadership and the social and organizational contexts that influence these challenges.

Although Hart’s (1991) review targeted leadership succession in general, York-Barr and Duke’s (2004) synthesis of the literature was specifically focused on the concept and

practice of teacher leadership within the past twenty years. The researchers organized this review around seven questions: (1) Why focus on teacher leadership? (2) How is teacher leadership defined? (3) What do teacher leaders do? (4) Who are teacher leaders? (5) What conditions influence teacher leadership? (6) How are teacher leaders prepared to lead? and (7) What are the effects of teacher leadership? York-Barr and Duke's review also highlights accomplishments, challenges, and recommendations for supporting teacher leaders.

York-Barr and Duke (2004) suggest that the literature base supports the claim that typically, teacher leaders are accomplished teachers who are respected by their colleagues. They explain that teacher leaders extend their knowledge, skills, and influence to others in their school communities. However, York-Barr and Duke note difficulties that teacher leaders experience. For example, they state that the roles of teacher leaders are often ill defined; rendering the relationship between teacher leaders and those they assist problematic. Teacher leaders also experience conflict and isolation as the nature of their collegial relationships transitions from being a classroom teacher to a leader. They describe, "A negative effect of these relationship shifts can be a sense of greater distance from and even a loss of specific, valued relationships with colleagues" (p. 283).

Nevertheless, York-Barr and Duke (2004) argued that the literature base upholds the notion that the school community can be critical in supporting teacher leaders. Teacher leaders' roles and expectations are more likely to be successful if they are mutually shaped and negotiated by teacher leaders, their colleagues, and principals on the basis of context-specific instructional and improvement needs. In addition, York-Barr and Duke

articulated that certain structures (e.g., professional development schools) increase the knowledge base of teacher leadership. Such structures will allow teacher leaders the opportunity to grow in their understanding of instructional, professional, and organizational practice as they lead.

Hart (1991) and York-Barr and Duke (2004) conducted separate syntheses of the literature related to teacher leadership. Although these reviews spanned decades of research, literature specific to mathematics teacher leaders or mathematics curriculum leaders was limited. In particular, teachers' transition to leadership roles upon the completion of a mathematics curriculum leadership graduate degree program has not been documented. The ideas discussed within Hart, York-Barr and Duke, and other researched publications helped identify key categories to discuss in this chapter. Based on the literature and research question for this study, this literature review is organized into four major categories: (1) the preparation or professional development of teacher/curriculum leaders; (2) the roles and actions of teacher/curriculum leaders; (3) the views of teacher/curriculum leaders; and (4) the challenges of teacher/curriculum leaders. These categories were discussed throughout the different literature bases and will set the stage for understanding teachers' transitions into the leadership roles they assumed upon completion of the mathematics curriculum leadership graduate degree program. Empirical studies are utilized for this review, but on occasion the discussion is supported by non-empirical work.

Teacher/Curriculum Leadership Preparation and Professional Development

New knowledge, tools, and ways of doing and communicating mathematics continue to emerge and evolve. The need to understand and be able to use mathematics in

everyday life and in the workplace has never been greater and will continue to increase (National Council of Teachers of Mathematics, 2004). As a result, school districts seek strategies to improve the teaching and learning of mathematics. In recent years, school districts have relied on teacher leaders or curriculum leaders to facilitate professional development and support classroom teachers at the school and district levels. Gigante and Firestone (2007) argue that teacher leaders have great potential to influence improvement, as they can have a positive impact on instruction and student achievement. Schools have high expectations for teacher and curriculum leaders. For example, teacher and curriculum leaders are expected to support classroom teachers in efforts to improve teaching practices, participate in change initiatives such as the adoption of new curricular materials, promote and facilitate collaboration, and create district resources including common assessments or pacing guides (Chval et al., 2010; Halai, 2007; Nickerson & Moriarity, 2005). Too often, teacher leaders try to meet these expectations with little to no preparation (Mangin, 2007; York-Barr & Duke, 2004). “We ask teachers to assume leadership roles without any preparation or coaching, because we assume they appear to intuitively know how to work with their colleagues” (Katzenmeyer & Moller, 2001, p. 47). With little preparation, teacher and curriculum leaders face overwhelming challenges.

At one time, teacher leaders’ preparation was related to their individual teaching experiences, since their backgrounds included successful accomplishments as classroom teachers (Barth, 2001; Even, 1999; Gehrke, 1991). Consequently, the idea was conceived that transitioning into positions of teacher leadership or curriculum leadership would allow former classroom teachers to extend their knowledge, skills, and influence to others

in their school communities. However, Even warns that “Being a good teacher does not necessarily imply the ability to help others develop their teaching, just as being a good mathematician does not necessarily imply the ability to help others learn mathematics” (p. 4). Teacher leaders and curriculum leaders need knowledge that goes beyond their classroom experience. For example, mathematics coaches needed to know: (1) how to build teacher leadership capacity at the school level, (2) how to work with colleagues who are resistant to improvement initiatives, (3) how to facilitate professional development, (4) how to collaborate with teachers to co-teach and analyze student work, and (5) how to provide resources related to improving teaching and learning (Chval et al., 2010).

Teacher leaders need adequate preparation to fulfill their responsibilities (Chval et al., 2010; Gigante & Firestone, 2007; Mangin, 2007; York-Barr & Duke, 2004). Researchers report that in recent years there has been more attention to implementing professional development programs to assist practitioners in becoming effective teacher leaders (Gigante & Firestone, 2007; Mangin, 2007; York-Barr & Duke, 2004). Professional development programs have included both formal training (e.g., programs sponsored by school districts, higher education, organizations) and informal training such as job-embedded mentoring from others and individual pursuits to develop new knowledge and skills.

Formal training.

Over the last two decades, there has been an increased call for professional development programs that are designed to equip teacher and curriculum leaders with opportunities to engage in topics that support their views, their actions, and their response

to challenges of being an effective leader (Chval et al., 2010; Even, 1999; Gigante & Firestone, 2007; Mangin, 2007; Nickerson & Moriarity, 2005). School districts and/or universities are leading efforts regarding the growth of such professional development opportunities (e.g., The Developing Mathematical Ideas Leadership Institutes) for teacher and curriculum leaders.

School districts and universities' professional development programs.

Teacher and curriculum leaders spend their time in professional development opportunities performing tasks related to teaching and learning (Chval et al., 2010; Even, 1999; Gigante & Firestone, 2007; Halai, 2007; Nickerson & Moriarity, 2005). For example, teacher leaders from the Teacher Leader Institute (TLI) -a collaboration of two universities and eleven schools- were engaged in development and support tasks to assist their growth (Gigante and Firestone, 2007). Descriptions of support and developmental tasks are given below:

Support tasks set the stage for successful teaching by facilitating teachers' work in the short run, but do not increase their human resources in the long run. Support tasks include managing materials or preparing laboratories, building confidence or generating enthusiasm, and piloting curriculum.

Developmental tasks increase human resources as the teacher leaders' contribute to the development of their colleagues' instructional knowledge and skills. Developmental tasks include designing activities or lessons, answering content questions, modeling or team teaching lessons, and facilitating professional development. (p. 311)

The TLI equipped teacher leaders with the capacity to examine instruction and relate it to student learning utilizing support and developmental tasks. The teacher leaders gained an understanding of appropriate material and social resources in facilitating their work. The different tasks allowed the teacher leaders to gain valuable knowledge for leadership,

teaching, and learning of mathematics. Subsequently, the TLI enabled teacher leaders to network with other teacher leaders.

In another study, Nickerson and Moriarity (2005) report on five aspects of mathematics specialists' professional lives that afford or constrain the development of professional communities at their schools. The five aspects are (1) relationship the mathematics teachers had with the school administration and other classroom teachers, (2) respect for and access to the knowledge of other mathematics teachers, (3) presence or absence of a teacher leader, (4) shared base of mathematical and pedagogical knowledge of the teachers, and (5) teachers' expectation that every child can learn. In doing so, the researchers outlined the professional development opportunities that the mathematics specialists experienced. The preparation for the mathematics specialists included an extensive professional development program in the form of mathematics and pedagogy courses taken at a local university along with six additional professional development days arranged by the school district. The university program consisted of twelve semester hours of coursework designed to earn a mathematics specialist certificate. In addition, the school district provided the mathematics specialists with substantial time for professional development in a shared office space. The focus of the mathematics courses was on learning elementary school mathematics in a "deep, connecting way" that would change beliefs about the nature of mathematics. The central theme of the pedagogy courses was on children's thinking about mathematics.

School districts' professional development programs.

In Chval et al.'s (2010) investigation of mathematics teachers-to-coaches transition, professional development opportunities included district monthly whole-group meetings

and Cognitive Coaching meetings. The district monthly whole-group meetings were twofold. These meetings provided professional development and support for the mathematics coaches. During these meetings, the mathematics coaches became acquainted with research from the National Research Council (NRC) publications, *Adding It Up: Helping Children Learn Mathematics* (NRC, 2001) and *How Students Learn: History, Mathematics, and Science in the Classroom* (NRC, 2005), as well as other texts to support their development. In addition, the mathematics coaches attended Cognitive Coaching meetings each month to promote their growth. Cognitive Coaching is “a method of instruction that recognizes the strength of metacognition and its role in fostering independent learning... Mentors act as mediator” (Costa & Garmston, 1997). Overall, these opportunities enhanced the mathematics coaches’ knowledge to better support teachers. Nevertheless, Chval et al. note, “Further awareness and support for coaches is needed as they transition into their new identities as instructional leaders” (p. 212).

In another study, Even (1999) reports on teacher leaders’ development through the Manor Project located in Israel. The Manor Project, funded by the Israeli Ministry of Education, was conducted over a period of three years in an effort to allow sufficient time for participants to learn, experience, and experiment with topics and ideas such as algebra, analysis, geometry, the real numbers, probability, statistics, and the use of technology for supporting the teaching and learning of mathematics. In addition, the Manor Project’s participants critically examined educational issues such as alternative assessment and teaching in heterogeneous classrooms. The program emphasized the development of leadership skills and methods for working with teachers and encouraged

discussion of practical difficulties and dilemmas. In the final year, the program also focused on initiating change in school mathematics teaching and learning. Results revealed that participation in the Manor Project gradually encouraged active participation of the teachers, usage of technological tools, and the development of teamwork. Their reflective abilities also developed considerably until they were able to criticize the teacher development activities they conducted and to suggest modifications. However, the balance between the need to support teacher learning and the need to initiate change appeared to be problematic and remained a challenge for the facilitators of the Manor Project.

Professional development programs offered by universities.

Universities offer courses and graduate study programs related to teacher leadership. However, programs directly related to mathematics curriculum leadership are not prevalent. Moreover, there has been minimal attention to studying how these preparation programs influence teacher leaders' views and actions. In one example, Halai's (2007) study critically examined her own role as a mentor to a group of mid-career mathematics teachers in which the researcher credits her development to a local university in Pakistan. Halai participated in a two-year master's degree (M.Ed.) course in teacher education prior to working as a mentor. The degree course was a part of a new program initiated by the university. The program offered a field-based education to students who would then go on to work jointly for a period of three years with the university and a school. Halai assisted with educating fellow teachers in their teaching methods along with enhancing their knowledge of the various subject matters. The knowledge acquired from this experience enhanced Halai's role as a mentor, as she describes:

I had learned many new strategies and ideas during the M. Ed. course and was now trying out some of them, such as the use of talk in promoting mathematical learning in my classroom. Seeing them being used, and later talking about issues and questions emerging from the use of these new strategies, I had hoped would give the teachers greater insights into them. (p. 311)

The program equipped Halai with knowledge to work with fellow teachers regarding the teaching and learning of mathematics. However, Halai posits challenges that need to be considered:

How could I as a mentor simultaneously

- address the issue of teachers' lack of mathematical knowledge and understanding,
 - establish a relationship with the teachers which was open and built on trust, and
 - help the teachers gain insights into alternative approaches to teaching?
- (p. 311)

Studies have verified that there are formal professional development opportunities for teacher and curriculum leaders. Through such opportunities, teacher and curriculum leaders can earn a certificate or degree to document their accomplishments. Although formal professional development opportunities have increased for teacher and curriculum leaders, there has been little empirical research on the influence of these programs on mathematics curriculum leadership, especially programs at higher education institutions. Therefore, attention to how degree programs assist mathematics curriculum leaders is needed.

Informal training.

Formal professional development structures for preparing teacher leaders and curriculum leaders have grown over the years. Curriculum leaders note that such programs have assisted them in developing their knowledge within the field (Klein, 1985). However, teacher and curriculum leaders look to other sources (e.g., other

teacher/curriculum leaders, administrators, teachers, professional literature, conferences) in their individual pursuits to assist them in gaining additional knowledge (Chval et al., 2010; Even, 1999; Gigante & Firestone, 2007; Halai, 2007; Mangin, 2010; Nickerson & Moriarity, 2005). These sources can be instrumental in supporting teacher and curriculum leaders' professional growth.

In Chval et al.'s (2010) study, mathematics coaches attended formal training opportunities that assisted their growth. Additionally, mathematics coaches' interactions with literacy coaches, principals, and teachers enhanced their knowledge and their views about leadership as well. For example, as a mathematics coach reflected on her conversation with a literacy coach, she was challenged to consider how she wanted teachers to perceive her as the following quote illustrates:

I am by no means an expert, and I don't want to come across as an expert. We were in a meeting and I was talking with one of the literacy coaches about work for this year and my thinking and feelings about next year. She said something about wanting people to see me as an expert and to come and help them with things. I responded, "No, I don't want to be an expert." She replied, "That is what your position is, isn't it?" I again responded, "No, it is not!" And then I felt stupid and thought maybe I am supposed to be the know-it-all, but I don't want it to be that at all and if that is what [being a math coach] is, I don't want it. I don't want anything to do with being the know-it-all. I don't have the answers and please don't ask me! I will work with you and try to figure it out together, but don't expect me to have the answers for everything. (p. 201)

The mathematics coaches in this study explained that interactions with others (e.g., instructional coaches, administrators, teachers) challenged their thinking and promoted their professional growth. In addition, they read professional literature to help foster their development.

Individual pursuits play an important role in guiding the intentional development of teacher and curriculum leaders (York-Barr & Duke, 2004). Informal training allows the

leaders to gain additional knowledge and support to carry out their duties successfully. However, teacher and curriculum leaders need both formal and informal training opportunities to assist them in becoming effective leaders for the school at large. Such opportunities equip teacher and curriculum leaders with necessary knowledge to work productively within their school(s).

Teacher/Curriculum Leadership Actions

Teacher and curriculum leaders assume a large number of roles and perform a variety of actions in their specific contexts. Cruz (2003) writes:

Teacher leaders are selfless communicators, mentors, and facilitators. They are avid listeners who share ideas, materials, or new teaching concepts to help all the participants of the school community, from the students, to the parents, to the staff, to the school's administrators, and to their fellow teachers. They are considered teacher leaders because of their positive, encouraging, and caring nature. And, they are teachers of mathematics because, as one teacher leader in this study said, "It's fun!" (p. 11)

Cruz's description suggests actions that leaders perform as well as personal qualities that characterize them. Other researchers have also described the actions of teacher and curriculum leaders. For example, Halai (1998) explained that as a mentor she "nurtures the personal and professional growth of the practicing teacher, i.e., the mentee" (p. 298). In addition, Halai identifies other actions of a curriculum leader as teaching, coaching, planning, observing, providing feedback, and reflecting.

In another study, Mangin (2010) reports principals viewed the teacher leaders' actions as being a resource for teachers. In particular, one principal explains:

The three administrators in the school and I... identify ourselves as curriculum leaders and the supervisors of instruction, and our expectations are clearly defined. So I think teachers try to come up to that, and they will use the resources. And we have clearly defined teacher [leaders] as an intervention for yourself, remediation for yourself, enrichment for yourself. (p. 344)

Furthermore, Mangin reports that the principals repeatedly communicated an expectation of instructional improvement, while simultaneously describing the teacher leaders as a useful instructional resource.

Actions of teacher/curriculum leadership evolve over time.

Although there is no general agreement on the actions that teacher and curriculum leaders should perform, the literature does identify a variety of roles they assume and actions they perform (e.g., establishing relationships, breaking down barriers, making resources available throughout the school organization) and demonstrates that these roles and actions have changed over time (Chval et al., 2010; Halai, 1998; Mangin, 2010; York-Barr & Duke, 2004).

Past actions of teacher leaders focused on sharing information and influencing others in matters related to curriculum and instruction (Silva et al., 2000; Even, 1999).

Typically, assistant principals, department chairs, and other district administrators fulfilled roles as teacher and curriculum leaders who had limited responsibilities inside classrooms. Often times, the decision to assume teacher and curriculum leadership positions was driven by a desire to transition into administrative positions. Teacher and curriculum leaders' roles usually lacked flexibility and required a lengthy, ongoing commitment of time and energy (Barth, 2001; Gehrke, 1991).

The term, curriculum leadership, began to emerge about two decades ago and promised real opportunities for teachers to impact educational change without necessarily leaving the classroom (Even, 1999; Gehrke, 1991; Klein, 1985; York-Barr & Duke, 2004). The role moved beyond the traditional approach of administrative positions described above to more complex and diverse positions (York-Barr & Duke, 2004).

Principals began to delegate responsibilities that had characteristically been part of their job descriptions to curriculum leaders. As a result, curriculum leaders began to be identified as master teachers, lead teachers, and other professionally committed teachers (Klein, 1985). Individuals who assumed the role of teacher leader or curriculum leader became a part of the decision-making process in which they performed a variety of actions as indicated by the following list (Campbell & Malkus, 2011; Gigante & Firestone, 2007; Halai, 1998; York-Barr & Duke, 2004):

- Act as a subject area resource person
- Assist with school level decision-making
- Build confidence and enthusiasm
- Design activities or lessons
- Facilitate action research
- Facilitate professional development
- Keep abreast of current research, literature, and practices in curriculum
- Manage the distribution of materials (e.g., textbooks, instructional materials) needed for teaching
- Mentor new teachers
- Model lessons
- Organize and participate in peer reviews of school practice
- Promote collaborative school environments
- Provide guidance in relation to curriculum decisions such as goal-setting, planning, developing and reviewing education programs and materials
- Review and monitor curriculum policies
- Serve as a coach or consultant to individual teachers
- Serve as department chair
- Supervise and evaluate teacher performance

Teacher and curriculum leaders are socially and politically conscious of the school system and committed to improving student learning. Teacher and curriculum leaders' actions appear to be immersed in their responsibilities in which they are expected to know the best forms of instruction and work closely with their colleagues by providing guidance and support. However, in order to be effective with their colleagues, teacher and curriculum leaders need to learn a variety of leadership skills including how to build trust

and develop rapport (i.e., team building), create communication networks, and deal with time and conflict management (Chval et al., 2010). The actions of teacher leaders have expanded beyond earlier identified descriptions to reflect improvement efforts of federal, state, and local standards alignment (Troncoso-Skidmore, 2007).

One of the strongest themes evident in the development of teacher leadership is the emergence of leadership that can be fostered in the context of learning communities. Today, teacher leaders know the best forms of instruction, nurture new school cultures that support collaboration and continuous learning, influence relationships within the school culture to affect student learning, contribute to school improvement, inspire excellence in practice, and empower stakeholders to participate in educational improvement (Chval et al., 2010; Mangin, 2010; Troncoso-Skidmore, 2007). In summary, as conceptions of teacher and curriculum leadership have changed, the resulting roles and actions of leaders have also changed.

Teacher/Curriculum Leadership Views

Teacher and curriculum leaders have views of the roles and responsibilities that they are to perform (Chval et al., 2010; Even, 1999; Halai, 1998). These views are in constant conflict and have influenced leaders' work. For example, in Chval et al.'s study of mathematics coaches, the coaches had idealized views that were in conflict with their realized roles. One mathematics coach explained her idealized view as: "I thought my job would be . . . seeing connections across grade levels, providing a more 'global view,' and sharing that with other teachers" (p. 200). Much like this coaches' view, other coaches believed that they would encourage teachers to improve their mathematics instruction, create an environment in their schools that emphasized mathematics instruction, plan

mathematics lessons and units, and build relationships, thus becoming the “resident mathematics expert” (p. 201). Still, these views did not agree with their realized views. “The coaches quickly realized that they would not always be welcomed into teachers’ classrooms” (p. 202).

Similarly, another researcher points out that teacher leaders’ views of students’ mathematical knowledge influence their roles (Even, 1999; Halai, 1998). “To make appropriate decisions for helping and guiding students in their knowledge construction certainly requires awareness of students’ conceptions and ways of thinking about the subject matter. A teacher who pays attention to students’ conceptual understanding can develop activities that challenge student thinking and support student learning” (Even, p. 12). The teacher leaders did not realize their view of the students’ knowledge, initially. However, the realization of this view enabled teacher leaders to further improve teachers’ mathematics instruction.

Idealized views are considered to be contradictory to the reality of teacher and curriculum leaders’ roles. Findings about teacher and curriculum leaders suggest that they experience conflicting views of the roles they are to assume (Chval et al., 2010; Even, 1999; Halai, 1998). However, with time and professional development opportunities, teacher and curriculum leaders’ views can change to alleviate such conflicting views. Professional development opportunities can assist them to perceive themselves as thoughtful learners that are prepared to be professional teacher and curriculum leaders, thereby, shifting their views of teaching and learning that will impact school mathematics (Even, 1999).

Challenges Teacher/Curriculum Leaders Encounter

Teacher and curriculum leaders can provide important benefits to the entire school community. Such a claim is supported by the substantial progress that has been made in understanding the extent of school leadership effects and the means by which teacher and curriculum leaders impact school performance. As stated by Fullan (2006), “It has become increasingly clear that leadership at all levels of the system is the key lever for reform, especially leaders who a) focus on capacity building and b) develop other leaders who can carry on” (p. 33). Gigante and Firestone (2007) add to this sentiment with the following: “It appears that the teacher leaders who engage in developmental functions are quite useful for facilitating educational change and improving teaching” (p. 323). At the same time, it is important to recognize that leaders face a variety of challenges or obstacles that influence their work and hinder their success as described in the following sections (Carver, 2010; Li, 2004, York-Barr & Duke; 2004).

Teacher/curriculum leaders’ roles and responsibilities are not established and explicitly communicated.

Problems often result when the expected roles and responsibilities of teacher leaders are not well defined (Chval et al., 2010; Mangin, 2010). “[Schools] fail to clarify the nature of the teacher leader position, thereby creating substantial role ambiguity” (Little, 1988, p. 2). When the actions for teacher and curriculum leadership are not well delineated, confusion results and tensions mount, not only for teacher and curriculum leaders, but also for other individuals (e.g., administrators, classroom teachers) in the school system (Chval et al., 2010; Nickerson and Moriarity, 2005). For example, the novice math coaches in the Chval et al. (2010) study expected that teachers would

welcome them into their classrooms, that they would spend the majority of their time supporting teachers in planning and instruction, that they would be successful in leading professional development sessions, and that their administrators would support their work. However, as these mathematics coaches assumed their positions, they encountered resistance from teachers who did not understand what role the mathematics coaches were suppose to play. The coaches were concerned that their roles and responsibilities were not well defined for the administrators and teachers in the district. As a result, the mathematics coaches worked together to create a document that clarified the nature of their roles and responsibilities (see *Figure 2*). Throughout the process of creating this description, the mathematics coaches collectively gained a better understanding of their roles and responsibilities and recognized that the lack of explicitness was an obstacle to their curriculum leadership efforts (K.B. Chval, personal communication, December 1, 2010).

Explicitly defining teacher and curriculum leaders' expected roles and responsibilities is critical to their effectiveness (Chval et al., 2010; Gigante & Firestone, 2007). Moreover, a variety of school members (e.g., teacher/curriculum leaders, principals, teachers) should share in identifying teacher and curriculum leaders' roles and responsibilities. Teacher and curriculum leaders who are given the opportunity to create and shape their own roles and responsibilities receive more support and experience greater success than those who are less willing and able to take this initiative (Carver, 2010; Hart, 1990; Li, 2004).

Description of Mathematics Coach Roles and Responsibilities

The district coaches that focus on mathematics are a collaborative team that facilitates and supports mathematics teachers' knowledge and practice.

Mathematics coaches:

- Advocate for quality mathematics teaching and learning as well as high expectations and opportunities for all students to learn mathematics;
- Help teachers identify professional goals to improve the teaching of mathematics and strategies for achieving those goals;
- Strengthen teacher knowledge related to teaching number, geometry, algebra, measurement, and statistics at the K– 8 level;
- Facilitate professional development as well as collaboration meetings (e.g., grade-level meetings, vertical team meetings, etc.);
- Help teachers design effective mathematics lessons that align with national, state, and district standards;
- Teach and co-teach lessons in individual classrooms for the purpose of improving the teaching and learning of mathematics;
- Observe lessons for the purpose of discussing mathematics and student thinking with teachers;
- Assist teachers with issues that specifically pertain to their classrooms such as curriculum planning, classroom management, assessment, and technology;
- Work with teachers to identify and address the needs of individual students including, but not limited to, special education, gifted, and students whose first language is not English;
- Collaborate with teachers to analyze student work to determine student understandings and misconceptions;
- Analyze student achievement data and work with teacher teams to design instruction that addresses areas that need improvement;
- Provide resources related to improving teaching and learning of mathematics;
- Build teacher leadership capacity at the school level;
- Lead district initiatives;
- Facilitate opportunities for teachers to observe other teachers teach mathematics in their schools or other schools;
- Assist teachers to design school improvement efforts such as math clubs, tutoring, intervention initiatives, etc.;
- Facilitate communication among teachers, parents, and administrators; and
- Help create a school environment where the importance of mathematics is evident.

Figure 2. Description of mathematics coach roles and responsibilities (Chval et al., 2010).

Teacher/curriculum leaders do not receive sufficient support.

As demonstrated above, teacher and curriculum leaders are expected to fulfill an overwhelming list of responsibilities in order to facilitate the professional growth of teachers and help students achieve high standards. Nonetheless, teacher and curriculum leaders do not always receive the support and encouragement from teachers and principals that they need in order to be successful (Chval et al., 2010; Mangin, 2010).

Lack of teacher support.

Teacher and curriculum leadership positions are intended to increase students' academic achievement by assisting teachers to improve their instructional strategies (Chval et al., 2010; Mangin, 2010; York-Barr & Duke, 2004). Expectations for teacher and curriculum leaders' actions are typically focused on supporting teachers. For example, teacher and curriculum leaders facilitate teachers' use of successful research-based instructional strategies through co-planning, co-teaching, and coaching. Gigante and Firestone (2007) report that teacher leaders interact with teachers who are "wonderful colleagues and some who are difficult" (p. 321). Teacher and curriculum leaders experience resistance from teachers. For instance, Chval et al. (2010) report (from mathematics coaches) "some teachers were resistant to their offers of support, appeared to take advantage of their offers of support, and/or did not appreciate their support" (p. 204). The mathematics coaches recognized that their new roles required new knowledge for interacting with teachers. The coaches wanted to know how to build a "teacher community." They wanted to know how to deal with teacher resistance and unprofessional teacher behavior (e.g., teachers lying about availability or stating that they didn't need help).

In another study, Halai (1998) acknowledges that her interactions with mentees (teachers) at her school assisted her development. “I learned that teacher learning was positively or adversely influenced, depending upon the relationship the mentee had with me. Building collegial relationships with the mentees was not a smooth or easy process. It required working in collaboration” (p. 304). Teacher resistance inhibits effectiveness. In order to decrease teacher resistance, Mangin (2005) suggests strategies are needed for teacher leaders to gain access to resistant teachers, which involve de-emphasizing instructional change in an effort to gain teachers’ trust. Teacher and curriculum leaders need the support of teachers. The balance between the need to support teacher learning and the need to initiate change seems to be a problematic issue that remains a challenge (Even, 1999).

Lack of administrator support.

A clear vision for teacher and curriculum leaders is desired and is depicted in North Central Regional Educational Laboratory’s (2007) report,

Schools are likely to be more successful in achieving in-depth learning when leaders work with staff and the community to build a collective educational vision that is clear, compelling, and connected to teaching and learning. This collective vision helps focus attention on what is important, motivates staff and students, and increases the sense of shared responsibility for student learning. (p. 1)

Teacher leaders often seek to collaborate with administrators to provide leadership and a vision for school-wide programs. However, teachers and administrators do not always have a clear and shared sense of purpose/vision for teacher and curriculum leadership (Chval et al., 2010; North Central Regional Educational Laboratory, 2007). Without a clear sense of direction, teacher and curriculum leaders can remain uncoordinated (Peterson, 1995; North Central Regional Educational Laboratory, 2007). When programs

become fragmented, teacher and curriculum leaders lose motivation and improvement efforts fail. Successful leadership efforts require the support of administrators to assist in planning and decision-making about programs, curricula, and instruction.

According to Little (2003), teacher and curriculum leaders spend most of their time performing tasks related to teaching and learning and not aimed at school or district improvement or organizational maintenance. Teacher and curriculum leaders support school administrators and reduce the growing list of responsibilities of the administrative staff, including those of the principal (Mangin, 2009). Specifically, teacher and curriculum leaders assist the administrative and instructional staff in interpreting data and designing approaches to improve student achievement and instruction (Olson, 2004). Although there is little known about the relationship between principals and teacher/curriculum leaders or how the principal may influence the effectiveness of teacher leaders, studies do report that teacher and curriculum leaders seek support from the administration to establish a vision along with addressing institutional structures to support teacher and curriculum leaders (Arbaugh, Chval, Van Garderen, Lannin, & Cummings, 2010; Chval et al., 2010; Gigante & Firestone, 2007).

School administrators play a critical role in supporting curriculum leaders, however, teacher and curriculum leaders report that administrators do not always provide support structures that they need (Chval et al., 2010). As a result, school district personnel need to carefully consider how they design, initiate, and implement support structures for curriculum leaders. Chval et al. write “Administrators and classroom teachers should be aware of the importance of these negotiations and structure opportunities for teachers, coaches, administrators, and others to share their expectations of coaches” (p. 212). This

acknowledgement of support structures requires a shift away from an individual role-based conception and towards a distributive view and a clearer set of design principles to guide the practice of large-scale improvement (Elmore, 2000). The school community along with teacher and curriculum leaders need to develop the knowledge and skills necessary to support the development of teachers.

More than interaction and indirect influence, teacher leaders want greater cooperation from the administration and affirmation of their work. Emerging research suggests that the effectiveness of teacher leadership roles is dependent, in part, on support received from the administration (Mangin, 2005). Mangin argues that teacher leaders need support for instructional improvement (e.g., meeting test-preparation goals) and affirmation of the work they do. Furthermore, district administrators can influence principals' level of support for teacher leaders by communicating the district's expectations of teacher leaders.

Time constraints.

Studies report that teacher and curriculum leaders experience time constraints, which significantly limit their ability to succeed in their roles (Chval et al., 2010). Time constraints (e.g., time to talk to other leaders, deal with conflicts, build collegial relationships) can pose significant challenges to teacher and curriculum leaders (Devaney, 2000). Teacher and curriculum leaders need time to fulfill the duties that are expected of them. For example, Chval et al. report that mathematics coaches were distracted from their coaching work by other responsibilities such as supervising recess, bus duty, and substitute teaching. Consequently, the coaches had limited opportunities to

meet with others to identify problems, brainstorm possible solutions, and support one another across the district.

Release time has a substantial influence on the success or failure of a teacher leadership initiative (Lord and Miller, 2002). Teacher and curriculum leaders are often forced to make professional sacrifices (e.g., less time to work with teachers) that compromise their ability to be effective in their roles. Additional responsibilities and little extra time are a hindrance for teacher and curriculum leaders. Teacher and curriculum leaders need their time to be protected (as much as possible) for the job they are supposed to do. Teacher and curriculum leaders face great challenges in securing time to effectively carry out their jobs.

Other challenges of teacher/curriculum leaders.

Teacher and curriculum leaders endure other challenges that deserve mention. For example, Chval et al. (2010) report, “mathematics coaches did not know how to coach, including what questions to ask teachers, how to challenge teachers’ thinking, and how to focus conversations on mathematics” (p. 208). In another study, a teacher leader talks about her interaction with students and posits the following statement: “One of the most important jobs that I have is to instill a desire to want to know and learn. This is challenging” (Nickerson & Moriarity, 2005, p. 126). Other challenges included teacher leaders’ struggles with their beliefs about mathematics and understanding mathematics along with how pupils learn mathematics (Halai, 1998). The challenges presented revealed that teacher and curriculum leaders need to learn not only how to deal with a vision, resistance, and time, but that they need knowledge that is relevant to their content areas (e.g., mathematics).

Conceptual Framework

Literature that included historical, philosophical, and technical views of teacher and curriculum leadership was utilized for this literature review. Historical, philosophical, and technical views provide an understanding of the cultural context and the prominent values through which teacher and curriculum leadership evolved in American education. Subsequently, the literature on teacher and curriculum leadership contributes to an understanding of what teacher and curriculum leaders need in order to be successful.

Based on the review of the literature, four critical components influence the work of mathematics curriculum leaders within their varying contexts: (1) professional development, (2) actions, (3) views, and (4) challenges (see *Figure 3*). These components are used to identify the professional development that mathematics curriculum leaders receive, the actions they carry out within these roles, the views of the roles they assume, and the challenges that they face within these roles. Nevertheless, three components, professional development, actions, and views, rely upon one another to influence mathematics curriculum leadership; hence, the bi-direction arrows. The challenge component demonstrates the hindrances and obstacles that are encountered within the three components (professional development, actions, and views) in the varying context of mathematics curriculum leadership. The framework for this study draws on these components to guide data collection and analysis efforts of mathematics curriculum leaders.

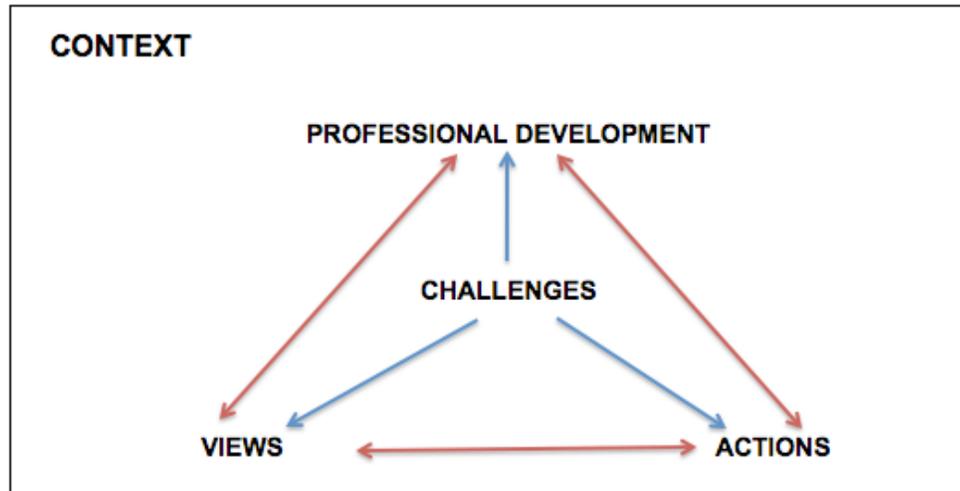


Figure 3. Critical factors that influence the work of mathematics curriculum leaders.

Summary

Studies suggest that curriculum leaders need specialized preparation and professional development to lead effectively. They must learn specific knowledge and develop leadership skills. Their participation in professional development will influence their views about leadership, teaching, and learning as well as the actions they perform in their leadership roles. In addition, the literature suggests that leaders encounter challenges that, in turn, influence their views, actions, and participation in professional development. All of this takes place in a social context. The social context in which teacher and curriculum leaders work influences how they understand and enact school policies, teaching, and learning. Teacher and curriculum leaders lead individuals (e.g., principals, teachers) to interpret and understand the policies and focus on components that assure students' success.

In addition, the literature on teacher and curriculum leadership reveals dimensions of practice, personal characteristics, and work conditions that promote and challenge teacher

leadership (Li, 2004; Wasley, 1991; York-Barr & Duke, 2004). However, little is known about how the participation in a mathematics curriculum leadership graduate degree program influences participants' views about leadership, the leadership roles they assumed, and their actions in relation to these leadership roles. Research is needed to understand the transition teachers make when they move from living their professional lives within the walls of their classroom to enlarging their professional lives as they assume leadership responsibilities (Ferrini-Mundy & Graham, 1997; Olson, 2004). The next chapter will detail the methods used to investigate the research question for this study.

Chapter 3: Methods

This chapter explains the management of this research study, including a discussion of each of the fundamental components: the research purpose and question, participant selection, data collection, and data analysis techniques (Creswell, 2003; NRC, 2002). In addition, I discuss how the reliability and validity of the data was documented.

Research Purpose and Question

In recent years, teachers have been selected for leadership roles. Some of these teachers have participated in professional development to prepare them for such roles. However, most new teacher leaders have not participated in specialized training due to a lack of opportunities as well as the assumption that effective teachers will be effective leaders. This assumption holds true for mathematics curriculum leaders as well. Designing useful professional development programs for potential and practicing mathematics curriculum leaders is critical to ensuring their effectiveness. Such programs will require a better understanding of the perceptions, skills, and work of mathematics curriculum leaders. More important, we need to understand how specialized professional development influences mathematics curriculum leaders' views, roles, and actions. The following research question guided this study:

How did participation in a mathematics curriculum leadership graduate degree program influence participants' views about leadership, leadership roles, and actions in relation to these leadership roles?

Research Design

This study employed qualitative research methods using a case study design. Yin (2003) posits:

Case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis. (p. 13)

A case study design allowed the use of multiple data sources to explore and describe participants' professional development, views, actions, and challenges associated with their mathematics curriculum leadership roles (Creswell, 2008; Patton, 1990). A case study design also permitted me to use a linear but iterative process to understand participants' viewpoints (Yin, 2003). This process utilizes six components (plan, design, prepare, collect, analyze, and share) in a repetitive flow in which "rich, in-depth" perspectives of the consented participants from the mathematics curriculum leadership graduate degree program were captured.

Yin (2003) describes six different types of case studies. Utilizing a 2×3 matrix concept, Yin describes such case studies that can be identified as single or multiple in that each bears the characteristics of being exploratory, explanatory, or descriptive. Single case studies capture an individual case of a phenomenon, while multiple case studies encompass two or more instances of a phenomenon that draws on a single set of "cross-case" conclusions. Exploratory case studies aim to investigate the questions and hypotheses of a subsequent study or the feasibility of the desired research procedures. An explanatory case study presents data bearing on cause-effect relationships, thus explaining how events happened. Descriptive case studies permit multiple data sources to explore, describe, and highlight relevant characteristics of the subject being examined, such as participants' leadership views, actions, and challenges.

Creswell (2008) adds to the 2×3 matrix with another dimension (as seen in Figure 4) by classifying Yin's six case studies as either intrinsic or instrumental. An intrinsic case study caters to an unusual case within a single or multiple design. This design is utilized when researchers have an interest in understanding a specific phenomenon. However, intrinsic case studies are not generalizable. An instrumental case study provides insight into an issue or theme. Such a case study illuminates a particular issue in a single or multiple design. Instrumental case studies provide researchers with a general understanding of a larger phenomenon. The particular case is not the priority, but understanding the larger, more global phenomenon is the purpose of the investigation.

	Exploratory	Explanatory	Descriptive	
Single	Intrinsic Single-Exploratory	Intrinsic Single-Explanatory	Intrinsic Single-Descriptive	Intrinsic
Multiple (collective)	Intrinsic Multi-Exploratory	Intrinsic Multi-Explanatory	Intrinsic Multi-Descriptive	Intrinsic
Single	Instrumental Single-Exploratory	Instrumental Single-Explanatory	Instrumental Single-Descriptive	Instrumental
Multiple (collective)	Instrumental Multi-Exploratory	Instrumental Multi-Explanatory	Instrumental Multi-Descriptive	Instrumental

Figure 4. Case study designs (Adapted from Creswell, 2008; Yin, 2003).

The goal of this study is to document the views, actions, and challenges faced by participants from a mathematics curriculum leadership graduate degree program as they transitioned into leadership positions. Drawing on the work of Yin (2003) and Creswell (2008), an *intrinsic multi-descriptive* case study was utilized to capture a collection of

descriptions from the participants to understand the specific phenomenon, mathematics curriculum leadership.

Participant Selection

The mathematics curriculum leadership graduate degree program was a three-year program that began in June 2005 as a partnership between a research-intensive university and a local school district. The program involved fourteen participants in a single cohort in which one member was a district mathematics curriculum coordinator and the other thirteen members were K-12 classroom teachers from the same school district. Members of this cohort were engaged in an in-depth program of study (see *Table 3*) to help them become effective mathematics curriculum leaders. The program of study consisted of thirty-two graduate credit hours. The course work focused on curriculum design, analysis, and implementation. During the summers, the participants studied topics including leadership development. The last year of the program included a research internship and a culminating project involving a written report along with a power point presentation. The mathematics curriculum leadership graduate degree program led to an Educational Specialist or Master's Degree in mathematics education from the university.

Table 3

The Mathematics Curriculum Leadership Program Of Study

Date	Program of Study
Spring 2005	Application Process
Summer 2005	Mathematics Curriculum: Manipulatives as Models K-12 (3 credit hours) Problems in Mathematics Education: Curriculum Policy (2 credit hours)
Fall 2005	Current Issues and Trends in Mathematics Curriculum (3 credit hours)
Winter 2006	Technology in Mathematics Education (3 credit hours)
Summer 2006	Mathematics Leadership Development (3 credit hours) K-12 School Curriculum: Rational Number (2 credit hours)
Fall 2006	Internship: Leadership and Professional Development (3 credit hours)
Winter 2007	Evaluating the Impact of Curriculum on Student Learning (3 credit hours)
Summer 2007	Mathematics Leadership: Influencing and Facilitating Improvement (3 credit hours) Readings in Assessment in Mathematics Education (3 credit hours)
Fall 2007	Examining the Learning and Teaching of Algebraic Reasoning in Grades K-12 (3 credit hours)
May 2008	Master's/Educational Specialist Project (1 credit hours)

Throughout the program, participants developed an understanding of mathematics curriculum leadership. Periodically, each participant recorded his or her experiences via writing prompts and/or reflective journals. For example, participants were encouraged to reflect upon their classroom practices, leadership experiences, and growth as mathematics curriculum leaders. The following writing prompts from December 2007 assisted the participants in their reflections:

- How have you grown as a curriculum leader in the last 2.5 years?
- What leadership roles do you fill now that you did not when you started the program?

- What have you learned about leadership in the last 2.5 years?

Similarly, during course discussions, participants engaged in numerous dialogues about the actions and challenges of mathematics curriculum leaders. In addition, each participant developed a manuscript for publication and was involved in designing and conducting a culminating project to explore mathematics curriculum leadership. All fourteen of the participants graduated from the program in May 2008.

Over the course of the three years in the mathematics curriculum leadership graduate degree program, ten teachers agreed to participate in research activities related to their participation in the graduate degree program and their subsequent leadership activities at their local schools. The consent from these ten teachers was solicited to further document experiences of mathematics curriculum leaders. However, only seven of the ten volunteers of the research activities continued their consent after the graduate degree program. These seven participants were the subjects of the study described here.

Context

At the beginning of the graduate degree program the seven participants (six females and one male) were classroom teachers from different schools within the same school district. Before the mathematics curriculum leadership graduate degree program, five of the participants were elementary teachers from various grade levels and the remaining two participants were secondary teachers (one taught junior high school while the other taught high school). The participants had varying levels of teaching experience, ranging from seven to twenty-three years. Three of the participants had 20-23 years of teaching experience, two participants had sixteen years, one participant had eight years while the remaining participant had seven years experience. Throughout the graduate degree

program, the participants took on leadership roles and responsibilities as they taught their respective grade levels (e.g., district mathematics curriculum leaders, vertical mathematics team members, mathematics item-writer for the statewide assessment test). They were not identified as formal mathematics curriculum leaders by the school or district. Instead, they volunteered for various roles and responsibilities as needed.

The participants' application for the mathematics curriculum leadership graduate degree program revealed demographic data, which is depicted in *Table 4*. To protect the anonymity of each participant, they have been designated as follows: MCL1, MCL2, MCL3, MCL4, MCL5, MCL6, and MCL7.

Table 4¹

Mathematics Curriculum Leader (MCL) Demographic Data as of 2005

Mathematics Curriculum Leader	Years of Educational Service	Gender	Areas/Grades Taught	Undergraduate Degree	Graduate Degree Prior to the Graduate Degree Program
MCL1	20	Female	Elementary Teacher: 1 st , 2 nd , and 3 rd	Bachelor of Science in Elementary Education	Master of Education in Curriculum and Instruction; Early Childhood Education
MCL2	23	Female	Elementary Teacher: Kindergarten, 1 st , 3 rd , 5 th , and 6 th	Bachelor of Science in Elementary Education	Master of Education in Curriculum and Instruction; Reading
MCL3	8	Female	Secondary Mathematics Teacher: 6 th , 7 th , and 8 th	Bachelor of Arts in Education	N/A
MCL4	21	Female	Elementary Teacher: Kindergarten, 1 st , 2 nd , 3 rd , and 4 th	Bachelor of Science in Elementary Education	Master of Education in Curriculum and Instruction; Mathematics
MCL5	7	Female	Secondary Mathematics Teacher: 10 th , 11 th , and 12 th	Bachelor of Science in Secondary Education; Mathematics	Master of Educational Leadership
MCL6	16	Female	Elementary Teacher: Kindergarten – 8 th for deaf students, 2 nd , 3 rd , 4 th , and 5 th	Bachelor of Arts in Deaf Education; Dual Certification in Elementary and Deaf K-12 Education	Master of Education in Special Education; Learning Disabilities
MCL7	16	Male	Elementary Teacher: 4 th , 5 th	Bachelor of Science in Elementary Education	N/A

¹ Per Participants' Applications

Data Sources

Various data sources were utilized to investigate the research question. Some data sources were collected while the teachers participated in the three-year graduate degree program and these sources included program applications, questionnaires, interviews, field notes, and written responses to questions raised by instructors. In addition, data was collected from the participants in Spring 2011 via an interview. Utilizing these different types of data collection instruments provided opportunities to corroborate themes that emerged along with triangulating the data (Creswell, 2008; Patton, 2002).

Program applications and questionnaires.

Prior to starting the three-year graduate degree program, participants completed an application and questionnaire (see Appendix A) administered by the program evaluator. Information gathered included participants' experiences related to teaching and professional development. In addition, participants were asked about their views of leadership and their leadership roles before starting the program.

Interviews.

The participants were interviewed three times. The program evaluator conducted the first interview when the participants entered the program in Summer 2005. The program evaluator conducted the second interview as the participants completed the program in Spring 2008 (see Appendix B for the interview protocol that was used for these interviews). In Spring 2011, I then conducted follow-up interviews (see Appendix C for this interview protocol). During this interview, specific questions were asked related to the components of the conceptual framework (i.e., context, professional development, views, actions, challenges) and the relationships among the components such as how their

participation in the graduate degree program influenced their roles, views, and actions. This interview provided an opportunity to collect data about participants' leadership activities during the three years following the completion of the mathematics curriculum leadership graduate degree program. The interview protocol was used to ensure that the data was comparable across the seven participants (Creswell, 2003; Creswell, 2008; Patton, 2002). All interviews were audio recorded and then transcribed using *Express Scribe*.

Field notes.

Qualitative researchers whose main objective is to understand the true perspectives of the subject being studied utilize field notes (Emerson, 1995). Following each interview that I conducted, I wrote field notes about information that was not captured on the audio recorders as well as important ideas I thought about during the interviews. Creswell (2008) points out that field notes can be descriptive or reflective in which descriptive field notes "record a description of the events, activities, and people (e.g., what happened)" while reflective field notes "record personal thoughts that the researchers have that relate to their insights, hunches, or broad ideas or themes that emerge during the observation" (p. 225). Both reflective and descriptive field notes were written following each interview to capture ideas that arose during and after the interview.

Artifacts.

Over the course of the three-year graduate degree program, the participants' course work including journals and written responses was collected. These artifacts provided data that captured participants' views, roles, actions, and challenges related to leadership during the course of the graduate degree program.

Data Analysis

Three primary phases of data analysis, as illustrated in *Figure 5*, were used in this study. During the first phase, an analysis was conducted of the existing data sources including the applications, initial surveys, transcripts of the pre- and post program interviews, and course artifacts for each participant (Creswell, 2003, 2008; Patton, 2002). Data was coded utilizing the conceptual framework as a guide in *Nvivo 8* –qualitative research software. *Nvivo 8* was also used to assist in data organization and management. To ensure consistency, a coding dictionary was created (see Appendix E for the coding dictionary), which includes key phrases associated with the conceptual framework.

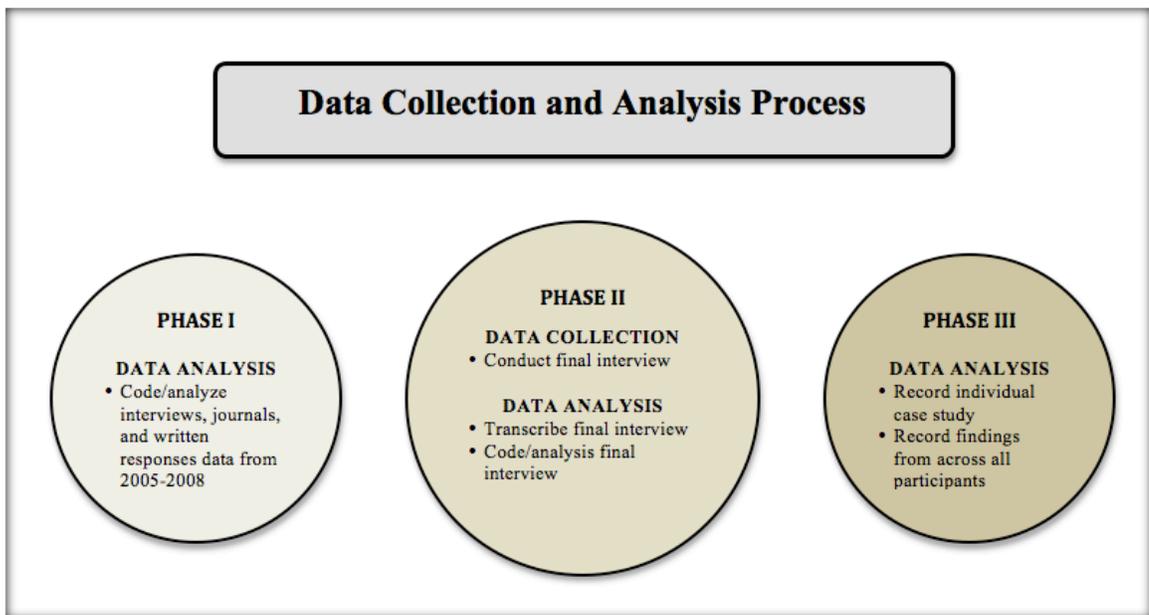


Figure 5. Data collection and analysis process.

As the data were coded, common patterns, as well as differences were compared (Creswell, 2003, 2008; Patton, 2002). Notes and memos were prepared to summarize each participant’s leadership roles and actions, their views about leadership, their

challenges, and their professional development experiences. The notes and memos were used to produce specific questions for the Spring 2011 interview (Patton, 2002).

Prior to the second phase of data analysis (refer to *Figure 5*), the 10 consenting participants from the graduate degree program were contacted via email (see Appendix D) to secure consent. Seven of the mathematics curriculum leaders agreed to take part in this study. Final interviews were conducted and transcribed in Spring 2011. When analyzed, categories emerged from the data that were exhaustive, mutually exclusive, conceptually congruent and reflective of the purpose of this study (Creswell, 2003, 2008; Patton, 2002; Yin, 2003).

During the final phase of data analysis (see *Figure 5*), a case study was prepared for each participant based on components of the conceptual framework. An analysis across all participants was carried out (Creswell, 2003; Patton, 2002). All analyses were verified utilizing interrater reliability (Creswell, 2008). That is, three educators coded a full interview transcript independently using the coding dictionary (see Appendix E). The codes were discussed and compared until a consensus was reached. Upon the success of the verifications of the analyses, rich detailed descriptions of the participants were developed.

Validity and Reliability

Yin (2003) describes three principles for obtaining validity and reliability of a study: (1) using multiple sources of evidence, (2) creating a case study database, and (3) maintaining a chain of evidence. The design of this study took into account these principles as described below.

Multiple sources of evidence.

This study involves five primary data sources (applications, questionnaires, interviews, field notes, and artifacts) that document participants' views, actions, challenges, and professional development experiences over the course of several years. As noted by Yin (2003) "Any finding or conclusion in a case study is likely to be much more convincing and accurate if it is based on several different sources of information, following a corroboratory mode" (p. 98). In addition, Patton (2002) posits that triangulation adds strength to a study and "increases credibility and quality by countering the concern (or accusation) that a study's findings are simply an artifact of a single method, a single source, or a single investigator's blinders" (p. 563). Using different data sources increases the study's accuracy of findings and helps address construct validity by providing multiple measures of the same phenomenon.

Recording data.

Data collected were organized and stored in a manner that made retrieval efficient and logical. Several methods of data recording were utilized during the data collection phase of this study, including taking notes on a laptop computer of relevant artifacts. An audio recorder, in conjunction with handwritten field notes, was used to record data from interviews. Subsequently, the interview recordings were transcribed verbatim and catalogued in an electronic database, namely *Nvivo 8*.

Maintaining a chain of evidence.

Establishing and maintaining a chain of evidence is "to allow an external observer—in this situation, the reader of the case study—to follow the derivation of any evidence, ranging from initial research questions to ultimate case study conclusions" (Yin, 2003,

p. 105). To address Yin's recommendation, I carefully documented the process that I used to collect and analyze the data. Aside from presenting the logic of data collection, there are other tangible ways to maintain the evidential chain. A case study design was utilized by citing referenced sources (applications, questionnaires, interviews, and artifacts), recording circumstances under which evidence was collected, and following stated procedures to ensure that the evidential chain was maintained.

Summary

Research on mathematics curriculum leadership has been limited. In particular, studies have not looked at the development and the effects of preparation programs on teacher or curriculum leadership (York-Barr & Duke, 2004, p. 255). Nevertheless, the case study methodology allows for an investigation of participants who transitioned into new roles of mathematics curriculum leadership subsequent to their involvement with a graduate degree program. The collection and analyses of interviews, writing responses, journals, and questionnaires allowed for examination of the work of mathematics curriculum leaders. A discussion of findings is presented in Chapter 4.

Chapter 4: Findings and Discussion

In this chapter, I present the findings of an analysis of participants' writing samples, journals, questionnaires, and interviews collected while they participated in and following a three-year mathematics curriculum leadership graduate degree program. I introduce the background (context) for each participant. Then I describe each participant's professional development, actions, views, and challenges before, during, and after their involvement in the graduate degree program. These sections offer evidence regarding how participation in a mathematics curriculum leadership graduate degree program influenced the leadership roles participants assumed along with their actions, and views about leadership. In addition, the sections offer evidence of the challenges encountered as the participants assumed new leadership roles. I will then present an analysis of the data across the cases based upon the research question.

Participant MCL2

Prior to joining the graduate degree program, MCL2 had 23 years of teaching experience at the elementary level. She taught kindergarten, first, second, third, fifth, and sixth grades in three different school districts. When MCL2 started teaching, she describes her experience as one where she instructed from the chalkboard and the students were to "do it this way" (MCL2.Summer2005.Interview). Her students then completed mathematics worksheets. She graded the students' work and returned the papers. Over time, MCL2 began to put additional emphasis on making mathematics "real and understandable" for her students (MCL2.Summer2005.Interview). For example, she gave students opportunities to work with current sports events and have them look at statistics and make predictions. However, MCL2 claims she was one of the last teachers

to buy into using the district's official K-5 mathematics curriculum, because she felt very confident in what she was doing with mathematics in her classroom. She finally accepted the value of using the district-adopted elementary curriculum materials, *Investigations*. MCL2 believes the curriculum materials helped her become a better teacher, focusing on student understanding. MCL2's teaching experiences over the years set the stage for her initial role and responsibilities as a mathematics curriculum leader for the school, district, university, and national organizations.

MCL2's preparation and professional development opportunities.

MCL2 participated in many professional development opportunities during her career (Questionnaire.2005). She participated in summer institutes where she learned about various mathematical topics. She eventually facilitated mathematical discussions with teachers from her school and district, as well as from other districts. MCL2 also indicated that she had informal professional development opportunities with colleagues. These opportunities were sometimes a conversation in passing (e.g., explaining a mathematics example to a teacher). These experiences advanced MCL2's growth in teaching mathematics and facilitating mathematics discussions with other educators. However, MCL2 did not mention any specific formal training in mathematics curriculum leadership (Questionnaire.2005). MCL2's interest in becoming a member of the mathematics curriculum leadership graduate degree program was fueled by her desire to have a better understanding of the K-7 mathematics curricula and various leadership models (MCL2.WS.CurriculumLeadership.061306).

During the mathematics curriculum leadership graduate degree program, MCL2 gained knowledge of various aspects of leadership and mathematics. In particular, her

knowledge of the mathematics curricula and school policies increased. MCL2 posited the following statements to validate this claim:

I feel much more knowledgeable about defining “curriculum.” I have a much greater understanding of how textbooks are selected, especially the politics of that [selection process].

As a member of the Achievement Gap group, my personal knowledge of the “gap” has grown tremendously. I know more about how it is measured, what can “cause” the gap, and ideas on how to “close” the gap. I am also much more aware of how SES [socioeconomic status], curriculum quality, teacher “quality,” minority attitudes, and test formats can affect that gap, either positively or negatively.

My own knowledge of NCLB [No Child Left Behind] has grown the most. I especially enjoyed the political aspect of it. (MCL2.Journal)

MCL2 credited the program for her growth in leadership. In the past, MCL2 strived to give wait time during mathematics discourse, whether it was to her students or teachers. In this endeavor she was not always successful. The program helped MCL2 realize the value of wait time during mathematics discussions. MCL2 recalled:

I have learned more than anything through all of these experiences [from the mathematics curriculum leadership graduate degree program] and with cognitive coaching, to try not be yapping first. I just need to sit back and let people process and let them talk before I do. (MCL2.Spring2008Interview)

Furthermore, MCL2 noted that the program equipped her with a better understanding about available research. She is now able to utilize research-related resources in her mathematical discussions with educators. In addition, MCL2 acknowledged that she knew how to lead workshops, but she credited the program for the boost in her confidence at facilitating workshops. As MCL2 puts it:

I feel a different type of confidence. I know that sounds weird, but I think now it is more of thoughtfulness. I don’t know if you can have degrees of confidence, but I was pretty confident before and thought I knew a lot of stuff, but now it is different. I don’t know how to explain it. It is more that it is at a different level, a deeper, quieter level. (MCL2.Spring2008Interview)

MCL2 contends that enrollment in the program along with the district's Cognitive Coaching program helped her to "blossom" (MCL2.Spring2008Interview).

In 2006, MCL2 attended the National Council of Supervisors of Mathematics (NCSM) spring conference. She selected sessions that focused on effective mathematics curriculum leader and indicated that these sessions were "perfect" for her mathematics leadership growth (MCL2.Spring2008.Interview).

The graduate degree program assisted MCL2 with opportunities for growth in the areas of the mathematics curriculum and leadership. She was afforded the opportunity to gain knowledge of the K-12 mathematics curricula and programs. This knowledge gain enabled her to think critically across strands and across grade levels as witnessed in the following quote:

I think you go in with a more critical eye and maybe can predict better how teachers might react or teachers might use the materials because we talked about that and really kind of worked through some curriculum issues. So I think that it helped me think more critically and more broad. (MCL2.Spring2011Interview)

The leadership component of the program was considered of particular value. This component of the program allowed MCL2 to experience how conflict works, how to work through conflict, how important it was to not tell but rather help teachers, and how to ask good questions to help them change and impact their thinking. Regarding conflict, MCL2 stated:

We [the cohort] talked a lot about that: what do you do when you come up against someone who's negative and we did a lot of talking about that ... There are ways to ask questions and ways to involve those people and to validate the way they are feeling and thinking and include them even though they don't seem like they want to be a part of the group and it's like how do you invite that person and how do you make sure that they are having opportunities to hear this even though that brick wall may be up and around them. What is it that you can do that might build trust with someone who thinks that you are making a personal judgment about

their teaching. And so, we did a lot of work around that and so that was very helpful. (MCL2.Spring2011Interview)

Furthermore, the program allowed MCL2 to work with a broader range of individuals, some with very different viewpoints and experiences than her own. The networking from the program allowed MCL2 to branch off and meet individuals, as portrayed in the following quote:

I think probably getting to work with people who are at very different places in their career, working with young professionals, and working with people who view teaching and instruction a lot different than I do because I, you know had opportunities to, I think I always try to pick people who thought like I did and hang out with those people because they validated me the most. Because of some of the opportunities, because I was in the cohort, we traveled to Michigan and worked with school districts there. It was kind of another off shoot, but if I hadn't been in the cohort that's how that person knew about me, so I was invited to do some things more than a couple of years ago during that time.
(MCL2.Spring2011Interview)

MCL2's completion of the graduate degree program earned her an Educational Specialist Degree in Mathematics Education. Since then, MCL2 has not experienced another formal training session geared specifically toward mathematics curriculum leadership. However, MCL2 continues to participate in mathematics meetings with her school and district. For example, she participated in the district's mathematics curriculum professional development in-service with a consultant of the district's mathematics program.

Roles and actions of MCL2.

Before the mathematics curriculum leadership graduate degree program, MCL2 spent most of her time teaching fifth graders. She was part of the mathematics initiative team, the district elementary mathematics leadership team, and the university advisory committee as shown in *Table 5*. These positions were a result of MCL2's principal's

appointment. Her principal relied on her to facilitate discussions about mathematics curricular topics (e.g., mathematical strands across all grades) with other fifth grade teachers in their building. As a member of the district elementary mathematics leadership team, MCL2 worked with educators outside of her building. These discussions centered on mathematical strands, while other topics would include the adoption of the district's K-5 mathematics curriculum. Additionally, MCL2 served on the advisory board for a university's mathematics education project. As a result of her involvement with these activities, MCL2 made presentations focused on mathematics curricula to other districts.

During the mathematics curriculum leadership degree program, MCL2 continued to have an assortment of mathematics curriculum leadership positions (i.e., the mathematics initiative team, the district elementary mathematics leadership team, and the university advisory committee). She facilitated discussions with fifth grade teachers in her district and facilitated a workshop in December of 2007 for the annual meeting of the Missouri Council of Teachers of Mathematics.

In 2008, MCL2 became a mathematics coach for her school district and was assigned to work with two schools. She was no longer responsible for teaching her own self-contained classroom. In this new position, she supported teachers in using the district's K-5 mathematics curricula by modeling lessons, conducting mathematics interviews with students, assisting teachers with an intervention for these students, making some administrative decisions related to instruction, and facilitating mathematics discussions. Many of these discussions were held during the school workday. MCL2 also worked with parents. She put together the school newsletter and made folders for parents whose child(ren) may not have qualified for special education services but struggled with

mathematics. During the summer, MCL2 worked with parents at a community center. She facilitated mathematics discussions with the parents, and the parents were given opportunities to practice mathematics using the district's K-5 mathematics curricula.

After working as a math coach for two years, MCL2 returned to teaching a self-contained fifth grade class due to budget constraints. In this role, MCL2 works with students, rather than teachers, the majority of time. In addition to her teaching duties, MCL2 continues to work as a mathematics curriculum leader. She was a member of two hiring committees for mathematics educators. She continued her involvement with the district's mathematics leadership team. She served as a member of the central executive board for the Missouri Council of Teachers of Mathematics (MCTM) and performed informal duties for faculty in her school. Within these roles MCL2 carried out many actions. As a member of the two hiring committees, MCL2 was responsible for assisting in the recruitment of members in mathematics education –one at the district level and the other at the university level. The graduate degree program aided her in fulfilling these roles as mentioned in the following passage:

I think being part of the cohort [within the mathematics curriculum leadership graduate degree program] helped me switch lenses, maybe that's a way to say it and kind of take on a different perspective or different kind of view than I was used to having. (MCL2.Spring2011Interview)

As a member of the district mathematics leadership team, MCL2 continued to facilitate discussions with teachers at school. In addition, MCL2 worked during the summer developing district mathematics assessments. MCL2's membership with the executive board for MCTM allowed her to suggest revisions to the organization's constitution and bi-laws. MCL2 also assisted with the MCTM mathematics contest.

Table 5²

MCL2's Formal Roles

Mathematics Curriculum Leadership Roles as of 2005 (while teaching 5th grade)	Mathematics Curriculum Leadership Roles as of 2008	Mathematics Curriculum Leadership Roles as of 2011 (while teaching 5th grade)
<i>School-Level</i> Mathematics Initiative Team <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> University Advisory Committee	<i>School-Level</i> Elementary Mathematics Coach, Mathematics Initiative Team <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> MCTM Elective Board	<i>School-Level</i> Mathematics Initiative Team <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> MCTM Elective Board, Host Teacher for Pre-service Elementary Teacher, Interview Team for Mathematics Education Positions

MCL2's views of mathematics curriculum leadership.

Upon entering the program, MCL2's views about the characteristics of a mathematics curriculum leader included descriptors such as being knowledgeable, experienced, and enthusiastic (see *Table 6*). MCL2 believed that a mathematics curriculum leader should be an advocate for students. MCL2 described her views of a mathematics curriculum leader in the following statement:

She is very enthusiastic and she truly views that her job is not just all about what I know and what I can do, but what do my kids know, what can they do, what do they need to be able to do and how do I get them there... I would add that you have to realize the reason you're there is not about you and it's not about the other teachers, it's about the kids. (MCL2.Spring2008Interview)

Furthermore, MCL2 believed that mathematics curriculum leaders should be firm in their beliefs, work well with teachers, and ask questions that move teachers in their thinking, thereby drawing ideas out of people. MCL2 recognized that working with adult learners is different from working with students. In dealing with students, she is able to use

² Per MCL2's Journal, Questionnaire, Writing Responses, and Interviews

gestures or “a touch on the shoulder” if they are being indifferent whereas working with adults requires different techniques (MCL2.Summer2005Interview). Therefore, MCL2 tried to avoid working with resistant teachers. She posited, “hopefully you [one of the professors with the programs] have some kind of bag of tricks” (MCL2.Summer2005Interview).

During the graduate degree program, MCL2 worked more with adults than she had before. Her views of leadership continued along the same lines that they had previously. She indicated:

It is kind of like working with kids in that you have to scaffold the learning. If you have a kid that can't subtract very well, obviously they are not going to leap into doing division with large numbers. You have to adjust. I also think with teachers you need to adjust. A teacher that is pretty well grounded in reform mathematics, their support is going to look very different than support that is coming from a very traditional point of view and doesn't really even know where to start. (MCL2.Spring2008Interview)

MCL2 also continued to view mathematics curriculum leadership as supporting students' learning of mathematics. She spoke of her vision of a mathematics curriculum leader as follows:

This person [mathematics curriculum leader] really knows their grade level mathematics. They really, really know it and they know what kids at that level think. They know what kids might say and do because of their past experience and their open-mindedness. (MCL2.Spring2008Interview)

However, during the program, MCL2 adds that she valued leaders who listen attentively. She notes, “It was also clear on the first day that you [graduate degree program professor] valued everyone's opinion. In responding to questions and comments, people were validated by your use of their names and your summaries or restatements of what each person said” (MCL2.WS.CommunityBuilding.062206).

Following her completion of the program, MCL2 continued to believe that a mathematics curriculum leader should focus on students as their main leadership activity. She added that everyone could be a mathematics curriculum leader in an informal capacity:

I don't think that there is any one definition about who that person is. I think that anybody who is interested in learning and learners can be that leader because we all, there are formal positions and there are informal positions. But even just having a conversation with somebody in the hallway can, you can act as a leader. You know, you walk over and say, I'm really puzzled about this kid and that response from the person can be a leadership role or it can be something as formal as being on a committee or being on a leadership team, but I think that we are all leaders for each other at some point, but we don't formalize that.... I see the definition more broadly than I did. (MCL2.Spring2011Interview)

MCL2 credits the graduate degree program for an expansion of her vision of a mathematics curriculum leader.

Table 6³

MCL2's Views of Curriculum Leadership

Views of Curriculum Leaders in 2005	Views of Curriculum Leaders in 2008	Views of Curriculum Leaders in 2011
<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Ask questions that move teachers in their thinking • Be enthusiastic • Be experienced • Be firm in their beliefs • Be knowledgeable • Have the ability to draw ideas out of people • Work well with teachers • Advocate <i>mathematics</i> for students 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be attentive • Be mindful and very cognizant of time as precious • Advocate <i>mathematics</i> for students 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Include ALL individuals • Attend and facilitate professional development opportunities related to <i>mathematics</i> education on local, state, and national levels • Advocate <i>mathematics</i> for students

³ Per MCL2's Journal, Writing Responses, and Interviews

Challenges of MCL2.

Before MCL2 entered the mathematics curriculum leadership graduate degree program, she noted challenges she experienced in her school context. For example, she desired additional support and knowledge that could further her leadership agenda.

MCL2 described a principal who was highly supportive of her and the leadership roles that she assumed. In fact, many of MCL2's leadership roles and responsibilities were assigned and/or recommended by her principal. However, this same feeling was not always felt emanating from others. MCL2 experienced a lack of support from teachers and parents. MCL2 recalls one time when she was facilitating a discussion with a group of teachers, "I mean I had some people when I did that [professional development session], some people did that [interjecting and taking the session off task]. I was always appalled. Teachers are the worst" (MCL2.Summer2005Interview). Teachers were doing things to get the discussion off track. MCL2 noted that dealing with this kind of situation is "really hard" (MCL2.Summer2005Interview).

MCL2 worked with parents over the years, some supportive and some "non-supportive" (MCL2.Summer2005Interview). In particular, some parents did not like the K-5 mathematics program that the district was using. Many of the parents wanted the school to go back to a more traditional textbook. MCL2 battled to get parents to understand that "kids will rise to expectations" if you have and set expectations (MCL2.Summer2005Interview). MCL2 looked to the program to assist her in dealing with unsupportive teachers and parents.

MCL2 sought out research literature that supported mathematics improvements. MCL2 looked to the mathematics curriculum leadership graduate degree program to learn

more about the K-12 mathematics curricula and research related to mathematics curricula and leadership.

MCL2 worked as a mathematics coach in two different school buildings. As a result, MCL2's time was limited and therefore she was not required to be a part of a school committee. In addition, MCL2 found it challenging to catch up on professional readings. MCL2 recalls, "I have a lot of material that I just haven't had time to read and digest" (MCL2.Spring2008Interview). Time was definitely a factor for MCL2's ability to keep current in professional literature.

MCL2 continued to experience challenges from teachers. On one occasion, MCL2 recalled a frustrating moment when she was trying to schedule a mathematics curriculum meeting:

I did have a situation with a person that I knew pretty well. I was trying to schedule grade level meetings at my other school because they don't meet very much... So, I was trying to set something up because some of them had requested some specific work looking at [the statewide assessment test] and they didn't want to do it by grade level. They wanted to do it after school so fourth grade teachers could hear fifth grade and it could be that vertical alignment... So, I was struggling with what dates I could do that. I wanted to do it after school. Well one teacher said, "I don't know why we can't do it during grade level meetings". I said, most of the people really want to talk across grade levels. There was a lot of interest so I want to try to accommodate that. So, then I would say, what about this day. Nothing worked. Well, I have a limited number of dates and times and this was all I had... So, this person said, you could do it in the morning but you choose not to...I was upset by that. It was like they just tried to dig at me and they did it on purpose... So, I felt like it was unnecessary and unprofessional on that person's part. I wasn't going to bend for the one person because I would have resented it the whole time. So, then I tried to schedule after school things and this person said, "if you do it this date then I can be there". So, I did. I had to cancel something else ... and they didn't even show up and didn't even make an excuse... I practically stood on my head and they didn't even come anyway and didn't even tell me why. So, that was just frustrating and there wasn't any good resolution to it other than I didn't let them push me over.
(MCL2.Spring2008Interview)

MCL2 felt supported by her administration, yet there were occasions when she was asked to do responsibilities unrelated to her position. For example, when her administrator asked MCL2 to be a substitute teacher. She was faced with having to turn this request down and stay out of sight for the remainder of the day in order to get her duties completed. Such requests, although not frequent, were definitely a challenge for MCL2.

Following the mathematics curriculum leadership program, MCL2 continued to interact with both supportive and unsupportive teachers throughout her school and district. MCL2 believed that it is important that she have district administrators and a local community who understood that teachers know how to make good decisions about instruction in their buildings and classrooms. She also expected district administrators, including mathematics coordinators, who had a good understanding about what occurs at the classroom level and knew how to help teachers grow professionally.

Participant MCL6

MCL6 began her teaching career working with hearing-impaired students, kindergarten through eighth grade. When she taught mathematics, she mainly focused on the language in mathematics with words such as “more”, “large”, and “one more” (MCL6.Summer2005Interview). However, when MCL6 began working with non-special education classes, second through fifth grades, she taught mathematics using mostly algorithms. MCL6 often had students write things down step-by-step in their notebook because this is what she had done when she was in school. MCL6 believed that she was good at mathematics throughout her years in school. She took enough mathematics in high school that she did not need to take any in college. Even so, 22 years later, MCL6

cringes at what she had done in the past. Perhaps the following illustration could explain this feeling:

I had an emotional experience in Denver in front of 50 people up at the overhead because we were doing a geometry problem and I reached for the graph paper where these high school teachers beside me went for the graphing calculators. And I'm cutting, I'm doing all this stuff and I got a different answer than they did so I thought mine must be wrong. But then I kept looking at it, but it can't be cause it's right here in front of me. So the instructor had me go do it on the overhead and just through their questioning a light bulb went off, that's why that formula works. Nobody had ever told me that. Here's the formula, apply it. (MCL5.Summer2005Interview)

MCL6 cried after this experience, in front of the 50 people. She wondered why couldn't someone have told her this 30 years ago, and she wanted kids to have that understanding. As a result, MCL6's teaching began to focus on understanding. She began using more problem solving and inquiry-based tasks. She spent a lot of time thinking about questions to ask the students that would draw the mathematics out of them instead of her doing most of the talking.

MCL6's preparation and professional development opportunities.

Preceding her entry into the graduate degree program, preparation and professional development opportunities for MCL6 included a master of education in special education with an emphasis on learning disabilities, school and district level in-services, and participating in mathematics teacher conferences.

At MCL6's school, professional development opportunities consisted of required collaboration time during which she and other teachers had mathematical discussions about the district's mathematics curricula and mathematical strands. At the district level, MCL6 participated in professional development that examined a mathematical strand (e.g., computational fluency) with the district mathematics supervisor. She attended

mathematics conferences such as the NCTM national and regional conferences. MCL6 also facilitated mathematics discussions of the 4th grade curriculum regarding the next unit of the program. However, MCL6 desired a broader understanding of how and when students learn new concepts in mathematics and how students' knowledge of mathematics grows across years and strands; hence, her enrollment in the mathematics curriculum leadership graduate degree program.

During the program, MCL6 taught elementary students and attended classes in the evening. She considered the program coursework to be hard, particularly the writing assignments. Still, MCL6 insists, "it was so worth it" (MCL6.Spring2008Interview). "I love this cohort group. It has had a large impact on my teaching and has helped give me a vision of where I want my teaching career to go" (MCL6.WS.CommunityBuilding.062206). MCL6 was able to meet new people and build relationships. Participating in the program addressed her need to learn about mathematics curricula and leadership development.

Working with the mathematics curricula, MCL6 was able to examine topics such as algebraic thinking and rational numbers, thereby increasing her knowledge about the mathematics across grade levels. The leadership component of the program afforded MCL6 opportunities to role-play various scenarios and examine personality profiles to determine strategies on how to deal with people effectively. This training fit with the cognitive coaching that MCL6 was undergoing as well. MCL6 appreciated that she was pushed in her writing and was able to publish an article in a professional teacher journal.

MCL6 gained more confidence as a result of the graduate degree program. The program assisted her in working within many of her mathematics curriculum leadership

roles to deal with teacher resistance and facilitating mathematics discussions. At the conclusion of the graduate degree program, MCL6 earned an Educational Specialist Degree in Mathematics Education. Since completing the program, MCL6 has not participated in professional development specifically related to mathematics curriculum leadership.

Roles and actions of MCL6.

Preceding the mathematics curriculum leadership graduate degree program, MCL6 taught fourth grade. She held leadership roles at the school and district levels throughout the school year as summarized in *Table 7*. She was a member of the district elementary mathematics leadership team, where she facilitated and trained colleagues in implementing the district's fourth grade mathematics curriculum. MCL6 was also a member of her school's leadership team. On this team, MCL6 met with colleagues once a month and made decisions about things that were going on in the building.

During the program, MCL6 experienced a shift in her roles as a mathematics curriculum leader. Most of MCL6's time was devoted to leadership work (see *Table 7*) rather than teaching elementary students. MCL6 facilitated mathematics curricular discussions as a member of the district's elementary mathematics leadership team and as a mathematics coach for two schools. As the mathematics coach, MCL6 conducted mathematics interviews with struggling students, modeled and observed lessons, and substituted when needed. On one occasion, she put together a measurement extravaganza for one of her schools. Other mathematics coaches assisted her by running the stations in which questions were posed to students. MCL6 also played a role as a member of the

“assessment for learning” team. She examined formative assessments for the district to assist teachers.

Following the program, MCL6 returned to the classroom teaching fourth grade. She continued to be a part of the district elementary mathematics leadership team along with being a member of the district K-8 leadership committee and the Response to Intervention (RtI) committee (see *Table 7*). The amount of time she devoted to these mathematics curriculum leadership roles was in constant flux, and she found it difficult to articulate a typical amount of time she spent in these roles. However, MCL6 desires a future role in mathematics curriculum leadership similar to that of a mathematics coach.

Table 7⁴

MCL6’s Formal Roles

Mathematics Curriculum Leadership Roles as of 2005 (while teaching 4th grade)	Mathematics Curriculum Leadership Roles as of 2008	Mathematics Curriculum Leadership Roles as of 2011 (while teaching 4th grade)
<i>School-Level</i> Building Leadership Team, Building Math Team	<i>School-Level</i> Mathematics Coach	<i>School-Level</i> Building Leadership Team, Building Math Team
<i>District-Level</i> District Elementary Mathematics Leadership Team	<i>District-Level</i> N/A	<i>District-Level</i> District Elementary Mathematics Leadership Team, RTI Team
<i>Other-Level</i> N/A	<i>Other-Level</i> N/A	Coordinator <i>Other-Level</i> N/A

MCL6’s views of mathematics curriculum leadership.

Prior to the graduate degree program, MCL6’s described mathematics curriculum leaders as having the ability to communicate, see the big picture, and understand the developmental processes (see *Table 8*). She believed that a mathematics curriculum

⁴ Per MCL6’s Journal, Questionnaire, Writing Responses, and Interviews

leader should be very good at questioning people to solicit what they believe, and what they know and, in turn, encourage improvement in teaching.

During the mathematics curriculum leadership graduate degree program, MCL6 experienced major changes to her views of a mathematics curriculum leader. First of all, she believed that a mathematics curriculum leader had various tiers of responsibility. Some leaders have the ultimate responsibility to answer to the central office (e.g., the district mathematics supervisors) while others work with teachers in an informal setting; thus, all teachers can be a mathematics curriculum leader. The goal for the mathematics curriculum leaders was to make sure kids are exposed the best mathematical learning opportunities. The mathematics curriculum leader should understand the mathematics standards, different mathematics curricula (including nontraditional versions), and best practices. More important, MCL6 believed that a mathematics curriculum leader should have an understanding of adult learners, various communication styles, and the dynamics of change. This person should have the “best” grasp of the content and should know how to work with students and be able to share that knowledge effectively with colleagues (MCL6.Spring2008Interview). A mathematics curriculum leader also needs a “toolbox” of strategies for facilitating discussions so that participants feel empowered to express themselves (MCL6.WS.CurriculumLeadership.062206).

MCL6’s views of curriculum leadership were similar prior to and following the graduate degree program. That is, MCL6 viewed herself as a mathematics curriculum leader, crediting the program for helping her to gain confidence in her leadership abilities and instilling communication skills. MCL6 highlights this sentiment in the following quote:

We did a lot of work with how to lead professional development with protocols and things like that and just communication skills and so I was able to bring that back to just even on a grade level team, to be able to use those types of skills. And I led PD for the staff on vocabulary and things like and but yet I used a lot of the same strategies that we used. (MCL6.Spring2011 Interview)

Table 8⁵

MCL6's Views of Curriculum Leadership

Views of Curriculum Leaders in 2005	Views of Curriculum Leaders in 2008	Views of Curriculum Leaders in 2011
<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be able to communicate (“the people skills”) • Be very good at questioning people to draw out of them what they believe and what they know • Encourage • Have an understanding of the developmental process for kids • Have the ability to see the big picture 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be knowledgeable about how to work with students and be able to share that effectively with colleagues • Have a “toolbox” of strategies for facilitating discussions so that participants feel empowered to express themselves • Have an understanding of adult learners • Have an understanding of the dynamics of change • Have an understanding of various communication styles • Have the “best” grasp of the content • Make sure kids are having the best <i>mathematical</i> opportunities to develop into the best <i>mathematicians</i> • Understand best practices in <i>mathematics</i> • Understand the different <i>mathematics</i> curricula (including nontraditional versions) • Understand the <i>mathematics</i> standards 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Have confidence in their leadership abilities • Attend and facilitate professional development opportunities related to <i>mathematics</i> education on local, state, and national levels

Challenges of MCL6.

MCL6 had taught from the district’s fourth grade mathematics curriculum and had facilitated professional development around discussions of the mathematics curriculum.

⁵ Per MCL6’s Journal, Writing Responses, and Interviews

She was knowledgeable about fourth grade curricula. However, MCL6 desired knowledge of the district's entire K-5 mathematics curricula. Furthermore, MCL6 needed knowledge to assist her in being a mathematics curriculum leader. She sought knowledge to help her lead, to make decisions of what should be done, what should be focused on, and to have the confidence to speak on behalf of the school needs. "I definitely want to have somebody to bounce things off of" (MCL6.Summer2005Interview).

Being involved in the graduate degree program, MCL6 expanded her knowledge of the K-5 curricula enabling her to explore mathematical topics across all grade levels. This knowledge contributed to her ability to serve as a mathematics curriculum leader. The program increased her confidence in her leadership abilities and communication skills. However, during the program, MCL6 continued to express a need for knowledge concerning mathematics curricula and leadership. In particular, MCL6 wanted to learn more about how to handle conflict and work with resistant teachers. She also wanted to know how the districts' mathematics curriculum standards and pacing guides differed from the district-adopted curriculum materials to better understand her district's demands.

Additionally, MCL6 experienced a challenge with the administrative staff. Occasionally, MCL6 was asked to substitute, which she felt detracted from her duties as mathematics coach. In addition, MCL6 did not have the time to devote toward readings and other materials. She acknowledged this as a factor that hindered her quest for knowledge outside of the program.

After the program, MCL6 continues to face challenges. MLC6 admits that there is fabulous literature out there, but she doesn't have the time to read it, study it, or try it out. Another challenge for MCL6 is scheduling assistance for teachers that still ask for help.

Participant MCL4

MCL4 started her teaching career as a learning disabled aide in third and fourth grades. The following school year, she began teaching as a fourth grade teacher. She described her early teaching style as “shadowing the mathematics textbooks and never venturing away” (MCL4.Summer2005Interview). Over time, MCL4 recognized that she needed to have a better understanding of mathematical concepts and how children think about mathematics; thus, MCL4's teaching style shifted. After 27 years of teaching elementary grades, kindergarten, first, first/second, third, and fourth, MCL4's knowledge of mathematics has grown and her roles in mathematics curriculum leadership have grown as well.

MCL4's preparation and professional development opportunities.

Before the mathematics curriculum leadership graduate degree program, MCL4's professional development included school district and building level in-service meetings. At the school level, MCL4 participated in weekly meetings with other third grade team members. Discussions centered around the mathematics that was occurring in their classrooms. MCL4 also participated in the school's monthly collaboration days. During one collaboration day, a member from a university facilitated a session on mathematical discourse with MCL4 and other teachers. As a result, MCL4 had the opportunity to observe mathematics lessons from other teachers in her building as part of her professional development experiences. These experiences were considered eye opening

and the “best learning” that MCL4 received (MCL4.Summer2005Interview). At the district level, MCL4 participated in informal professional development (MCL4.Summer2005Interview). This was mostly because she was usually one of the facilitators of mathematical discussions with third grade teachers in the district.

During the program, MCL4 continued her participation in professional development at the school and district levels. However, MCL4’s participation in the mathematics curriculum leadership degree program bestowed a sense of confidence in her. This was expressed in a conversation that MCL4 had with one of her professors from the graduate degree program:

You changed me. I mean that the leadership class and knowing that you can make a difference and it can be in a positive, diplomatic, open type of way that teachers will come. I truly believe that. I have read your articles and I have seen that if you dive into what you do and if you believe in what you do, that will resonate onto other people. (MCL4.Spring2008Interview)

MCL4 also noted that the program assisted her with her mathematical thinking. She found that working in cooperative groups played an important role in understanding mathematics. MCL4 commended the hands-on explorations opportunities, the assistance, and conversations with individuals at different levels of thinking. She believed that these experiences were “valuable” (MCL4.Spring2008Interview).

MCL4 received an Educational Specialist Degree in Mathematics Education and continues to express appreciation for the program. The program afforded her strategies and skills to help her in mathematics education and leadership. MCL4 believes that the instructors had a lasting impact on her. She articulates, “I learned a lot from the books, and the articles and everything, but I learned more from the leading by example of what a good teacher is, what good professors are. And we had good ones”

(MCL4.Spring2011Interview). Currently, MCL4 participates in required district professional development sessions.

Roles and actions of MCL4.

Before entering the mathematics curriculum leadership graduate degree program, MCL4 taught third grade along with carrying out mathematics curriculum leadership roles at her school and district (see *Table 9*). MCL4 was a member of the district's elementary mathematics leadership team. She facilitated many mathematics curriculum discussions to new third grade teachers centered on the district's third grade curriculum. MCL4 would also take information from the meetings to her school regarding the mathematics discussions. At the school level, MCL4 was a member of the vertical mathematics team in which she and other members of the team met to discuss mathematical topics such as computational concepts for an hour a week. They looked at the state's assessment data to assist them in improving their students' mathematics scores as well. Being on the vertical mathematics team, MCL4 stated, "I think it just helps keep that [mathematical] conversation open" (MCL4.Summer2005Interview).

During the mathematics curriculum leadership degree program, MCL4 experienced a change in her mathematics curriculum leadership roles, which resulted in a shift in her actions. MCL4 was no longer a third grade teacher; thus, she impacted students indirectly. MCL4 spent her time dedicated to the role of mathematics coach (see *Table 9*). As a mathematics coach, MCL4 was given more responsibility for modeling mathematics instructions within the classroom. She saw an increase in her actions with conducting professional development sessions for teachers. In addition, MCL4 remained a member of the district's elementary mathematics leadership team. She continued to share with

colleagues the information regarding what was happening with mathematics in the district.

Today, MCL4 is no longer the mathematics coach for her school. She has returned to teaching third grade. She continues to support teachers as a part of the district’s mathematics leadership team and informally through the halls of her school (see *Table 9*). Upon completion of the program, MCL4 did not desire a formal role in mathematics curriculum leadership, her reason being:

I missed the classroom immensely when I was a math coach. I missed the kids, I missed... I just missed it all. I missed seeing a child go from not knowing their numbers to being able to multiply. I mean, I just missed that challenge. I love, I like working with some adults, but then there are some adults that...it’s difficult and I think that I needed more time to hone those skills.
(MCL4.Summer2011Interview)

Table 9⁶

MCL4’s Formal Roles

Mathematics Curriculum Leadership Roles as of 2005 (while teaching 3rd grade)	Mathematics Curriculum Leadership Roles as of 2008	Mathematics Curriculum Leadership Roles as of 2011 (while teaching 3rd grade)
<i>School-Level</i> Vertical Mathematics Team	<i>School-Level</i> Elementary Mathematics Coach	<i>School-Level</i> N/A
<i>District-Level</i> District Elementary Mathematics Leadership Team	<i>District-Level</i> District Elementary Mathematics Leadership Team	<i>District-Level</i> District Elementary Mathematics Leadership Team
<i>Other-Level</i> N/A	<i>Other-Level</i> N/A	<i>Other-Level</i> N/A

MCL4’s views of mathematics curriculum leadership.

MCL4’s views of a mathematics curriculum leader were of an individual who is willing to learn, be a good listener, is willing to take risks, not afraid to make mistakes, and is affectionate for the mathematics curricula (see *Table 10*). MCL4 states, “I think

⁶ Per MCL4’s Journal, Questionnaire, Writing Responses, and Interviews

you need to know your curriculum forwards and backwards, but I think you also need to know the math that goes behind it” (MCL4.Summer2005Interview). In turn, a mathematics curriculum leader is then able to articulate this knowledge to classroom teachers. Mathematics curriculum leaders assist teachers in discovering answers to their own questions (e.g., what am I going to do next, what can I do to stretch the kids in that activity so that they’re not still counting by 1’s). However, MCL4’s views of herself as a mathematics curriculum leader were not favorable at this time. MCL4 viewed herself as “a crappy leader” based upon her perception of what a mathematics curriculum leader is (MCL4.Spring2008Interview).

During the program, MCL4’s views of herself as a mathematics curriculum leader improved. MCL4 realized that she did not know the qualities of a leader before the graduate degree program. She posits that the program assisted her with recognizing qualities that teacher leaders should possess, as mentioned in the following quote:

I think that if teachers took your class and saw what it took to be a leader, they would see that they weren’t. You can’t let things go over your head, you have to address them. If you truly feel like what people are doing is not the best for kids, you have to address that. You can’t just sweep that under the rug.
(MCL4.Spring2008Interview)

The program improved MCL4’s confidence to lead and support teachers with the mathematics curriculum. MCL4 notes that mathematics curriculum leaders need to possess confidence in order to lead adults.

Following the graduate degree program, MCL4 continued to encourage teachers to enhance their mathematics instruction. MCL4 states, “I feel like I am able to support them [teachers] and give them [teachers] some support in how we can intertwine [the past and current curricula]” (MCL4.Spring2011Interview).

Table 10⁷

MCL4's Views of Curriculum Leadership

Views of Curriculum Leaders in 2005	Views of Curriculum Leaders in 2008	Views of Curriculum Leaders in 2011
<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be a good listener • Be willing to learn • Be willing to take risks • Not be a crappy leader • Not be afraid to make mistakes • Be able to articulate their knowledge to classroom teachers • Assist teachers in recognizing answers to questions to assist their own learning (i.e., what am I going to do next, what can I do to stretch the kids in that activity so that they're not still counting by 1's) • Be affectionate for the mathematics curricula 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Attend and facilitate professional development opportunities related to mathematics education on local, state, and national levels • Be confident to lead and support teachers with the mathematics curriculum 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be confident to lead and support teachers with the mathematics curriculum

Challenges of MCL4.

MCL4 noted challenges before entering the mathematics curriculum leadership graduate degree program including a need for knowledge and staff-support to improve her abilities as a mathematics curriculum leader.

Going into the program, MCL4 had challenges with the mathematics curricula and leadership. MCL4 needed her actions as a mathematics curriculum leader better defined. She sought knowledge that could answer the following three questions: “What are the techniques for organizing information and deciding what information should be covered? What are the methods to keep participants involved and interested [in professional development]? What are the systematic ways to help teach mathematical concepts, the

⁷ Per MCL4’s Journal, Writing Responses, and Interviews

methods to pull it all together, and find the most important points of a curriculum?” (MCL4.Summer2005Interview). MCL4 credits the program for assisting her in finding answers to these questions.

MCL4 wanted to gain a better understanding of the NCTM’s *Principles and Standards for School Mathematics* and the state’s grade level expectations. She knew the standards and expectations on the surface, but felt a need to better comprehend them. While MCL4 was in the program, she was able to gain a more complete understanding of the standards and expectations. This enabled her to realize that the district’s K-5 curricula were aligned directly to the state’s grade level expectations and indirectly to NCTM’s *Principles and Standards for School Mathematics*.

MCL4 had experience dealing with resistant teachers before entering the program. For example, when fellow teachers expressed a dislike for the current mathematics curriculum, MCL4’s response was to redirect teachers, as she would do with her students. She gave an example of a moment when she worked with uncooperative teachers:

I would just continue to redirect, and just say well, why? Is this related to what we’re talking about or can you relate it to what we’re talking about? ...I mean I almost would do it like my kids in the classroom I guess because kids are like that. And I guess I would just basically use the same methods that I would with my third graders. (MCL.Summer2005Interview)

MCL4 expressed a need for support working with teachers and other leaders, while enrolled in the graduate degree program. MCL4 struggled with resistant teachers and other mathematics coaches. One such incident was when the mathematics coaches were unhappy with their school assignments for the upcoming school year. Many of them were to work with two schools or had been relocated to another school. This was not the case

for MCL4. She felt resentment from the other coaches since there was not a change in her assignment.

At her building, MCL4 encountered resistance from some members of the faculty. This resistance resulted in MCL4 not being able to communicate effectively with the third grade team at her school because of teachers dominating the team meetings. MCL4 gained a modicum of relief from teacher resistance toward the end of the graduate degree program. Some of the resistant teachers were assigned to another school.

After the program, MCL4 no longer works directly with teachers because the district eliminated her position as mathematics coach due to budget cuts. However, MCL4 continues to learn about mathematics on an individual basis, but would like opportunities to engage in mathematical discourse with other teachers.

Participant MCL1

MCL1 is an elementary teacher who has taught for 26 years in two different school districts. She taught 8 years in a rural school district before moving to her current district. MCL1 has experience in teaching first, second, and third grades with most of her teaching career has been at the first grade level. When MCL1 began teaching elementary students, she admits that she presented mathematics in a very traditional way. She recalls, “it was just totally memorizing everything...we started on page 1 and we went page by page by page” (MCL1.Summer2005Interview). She was the driving force for classroom discussions. MCL1 recognized that this way of teaching was not effective for her students. Through continual professional development, both formally and informally, MCL1 began to shift her thinking to believe that students should be given time to think through the mathematics that had been presented to them. This realization changed

MCL1's philosophy of teaching. She states, "My whole philosophy about teaching I think has changed and how, I understand how important it is that you let that child construct that knowledge" (MCL1.Spring2008Interview). Once MCL1 began to modify her thinking about the way students learn mathematics, she began to see a shift in her role as an elementary teacher. She became an advocate for students, thus taking on leadership roles that assisted her understanding of mathematics teaching and learning.

MCL1's preparation and professional development opportunities.

MCL1 was new to her role of mathematics curriculum leader before entering the mathematics curriculum leadership graduate degree program (MCL1.Summer2005Interview). Accordingly, MCL1's preparation and professional development opportunities prior to the program were not specifically designed for leaders, but were available to all the elementary teachers in her school or district. As she participated in meetings, professional development sessions, and book studies about mathematics teaching with colleagues and her principal, she gained knowledge and experience. MCL1 described some of her professional development experiences:

I attended a workshop for professional development for TERC [Investigations in Number, Data and Space mathematics curriculum] last summer for a week in Texas. (MCL1.Summer2005Interview)

It's really more district-wide. We'd also, we do some professional development in our building. It's mostly like book study kinds of things. We did like a comprehension book study so it's more like that kind of stuff. (MCL1.Summer2005Interview)

Prior to starting the graduate degree program, MCL1 took the initiative to participate in opportunities that would help her become a better teacher of mathematics, but nothing specific to mathematics curriculum leadership.

After participating in the graduate degree program, MCL1 recognized the value of professional development for teaching mathematics. She conveyed, “I think that whole professional development part of a math program would be something that I would really think would be so important where I don’t know if I would have really recognized that even two years ago” (MCL1.Summer2008Interview).

Because of her involvement in the graduate degree program, MCL1 began to think differently about the mathematical experiences that children should have, believing that students should be given fewer ideas to explore in order to develop an in depth understanding of mathematical topics. MCL1 shared this thought, “I see now where I should have had very different discussions with kids in first grade” (MCL1.Spring2008Interview). She believed that professional development was essential to encourage teachers to see the reality of developing an in-depth understanding of mathematical topics.

Upon completion of the mathematics curriculum leadership graduate degree program, MCL1 received an Educational Specialists Degree in Mathematics Education. The specialized mathematics training acquired from the program motivated MCL1 to become “more global” in the way she thought about mathematics (MCL1.Spring2011Interview). MCL1 now seeks and reads literature related to how students think and achieve in mathematics. MCL1 shares a moment she had regarding a professional development experience after the program:

Last year and even in prior years, I just never had sat down and just read a book about kids learning, unless it was class or something. Last year somehow, and I don’t know how I came across it. I came across a book called something about the global achievement gap... I never would have read a book like that before I took classes, never. (MCL1.Spring2011Interview)

Since completing the program, MCL1 has not participated in further formal training that is specific to mathematics curriculum leadership.

Roles and actions of MCL1.

MCL1 held mathematics curriculum leadership roles at the school and district levels before her involvement in the mathematics curriculum leadership graduate degree program. At the district level, MCL1 was a member of the district elementary mathematics leadership team (see *Table 11*). One of her responsibilities included designing and facilitating mathematics curriculum workshops for other teachers in her district as well as teachers from another district that used the same mathematics curriculum. These workshops were designed to help teachers implement both districts' mathematics curriculum. MCL1 worked with other leaders to expand upon ideas from the mathematics curriculum. For example, one year MCL1 and other mathematics leaders across the district met to focus their attention on the mathematical strand, computational fluency. They examined what this strand consisted of across grade levels and offered suggestions for improvement. This was common. MCL1 added that they were "always looking at a new aspect of the curriculum" (MCL1.Summer2005Interview). MCL1 also prepared informative documents to assist teachers in the district with interpreting and improving mathematics assessment scores.

MCL1 admits that most of her leadership actions during this period were at the district level. Nonetheless, MCL1 facilitated and participated in book studies with colleagues at her school. MCL1 also engaged parents in meaningful workshops to assist them in helping their child(ren) with mathematics at home.

MCL1's roles and responsibilities as a mathematics curriculum leader shifted while enrolled in the program. She spent the majority of her time in a leadership role working with adults (see *Table 11*). She carried out roles such as being a mathematics coach for her school, a member of the district's assessment for learning team, a member of the special education mathematics team, a member of the student assistance team, and continued as a member of the district elementary mathematics leadership team.

These roles altered MCL1's actions. MCL1 continued to facilitate book studies with teachers and have mathematics discussions with parents along with facilitating professional development sessions for the district on topics from the mathematics curriculum. However, new actions for MCL1 included assisting teachers (i.e., modeling lessons, planning lessons, assembling mathematics packets for parents, conducting student mathematics interviews), meeting with each grade level monthly in her building, attending district board meetings, and other miscellaneous tasks to assist the school (e.g., bus duty). Many of these actions were a part of her new position, mathematics coach.

Following the completion of the program, MCL1 no longer takes on the majority of the roles and responsibilities that she had during the program (e.g., mathematics coach, membership with the district's assessment for learning team, membership with the special education mathematics team, membership with the student assistance team). After, two years as a mathematics coach, MCL1 accepted a position as a fifth grade teacher. However, rather than teaching in a self-contained classroom, MCL1 teaches mathematics to all fifth grade students at her school. MCL1 continues to facilitate book studies with teachers in her building. At the district level, MCL1 remains a member of the district

elementary mathematics leadership team. Opportunities to work with teachers at the district level, however, have decreased this school year.

Table 11⁸

MCL1's Formal Roles

Mathematics Curriculum Leadership Roles as of 2005 (while teaching 1st grade)	Mathematics Curriculum Leadership Roles as of 2008	Mathematics Curriculum Leadership Roles as of 2011 (while teaching mathematics to all 5th grade)
<i>School-Level</i> Fellows Mentor	<i>School-Level</i> Fellows Mentor,	<i>School-Level</i> Mathematics Teacher for 5th
<i>District-Level</i> District Elementary Mathematics Leadership Team	Elementary Mathematics Coach, Mathematics, Special Education Mathematics Team	Grade <i>District-Level</i> District Elementary Mathematics Leadership Team
<i>Other-Level</i> N/A	<i>District-Level</i> District Elementary Mathematics Leadership Team	<i>Other-Level</i> N/A
	<i>Other-Level</i> N/A	

MCL1's views of mathematics curriculum leadership.

Prior to her participation in the program, MCL1 identified general qualities that mathematics curriculum leaders should possess. MCL1 felt that a mathematics curriculum leader should be knowledgeable, a positive role model, willing to share with others, a learner, and a practitioner. Aside from these characteristics, MCL1's views of a mathematics curriculum leader included individuals who accept and value different learning styles and advocate for kids. She also believed that mathematics curriculum leaders needed "to be at those kinds of workshops, where we're breaking ground, and always looking at a new aspect of the [mathematics] curriculum" (MCL1.Summer2005Interview). MCL1's views of mathematics curriculum leadership were based upon her insights gained through her years of teaching.

⁸ Per MCL1's Journal, Questionnaire, Writing Responses, and Interviews

Participation in the graduate degree program brought about a change in MCL1's views regarding the roles and responsibilities of mathematics curriculum leaders. She began to display more of a focus on supporting teachers and the mathematics content. She expressed interest in advancing teachers' thinking about mathematics and mathematics teaching, being a catalyst for teachers to think about mathematics in a different way, and supporting teachers in their classrooms (see *Table 12*). MCL1 also believed that mathematics curriculum leaders should read professional literature on mathematics curriculum and instruction and reflect upon those readings.

MCL1's views of mathematics curriculum leaders continued to expand subsequent to her involvement in the graduate degree program (see *Table 12*). She began to focus more on the mathematics curriculum and standards at state and national levels. She believed a mathematics curriculum leader should be aware of district, state, and national mathematics expectations and factors that influence curriculum. Although MCL1 is no longer a mathematics coach, she views a mathematics curriculum leader as being a coach to teachers. MCL1's involvement in the program enabled her to grow as a mathematics curriculum leader and become a better listener. She asserted, "I think I just became a better listener... I think a key part to being a leader is to listen and not just talk" (MCL1.Spring2011Interview).

Table 12⁹

MCL1's Views of Curriculum Leadership

Views of Curriculum Leaders in 2005	Views of Curriculum Leaders in 2008	Views of Curriculum Leaders in 2011
<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Advocate for kids • Be a learner • Be a positive role model • Be a practitioner • Be knowledgeable • Be willing to share with others • Accept and value different learning styles 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be accepting • Be flexible • Be hard working • Be motivated • Value teachers • Be in teachers' classrooms • Endorse students working in learning communities • Have really good people skills • Maintain a repertoire with teachers • Be knowledgeable about <i>mathematics</i> curricula, instruction, and assessment in general for all grade levels • Bring teachers forward in their thinking and ideas of <i>mathematics</i> • Endorse students to know <i>mathematics</i> conceptually • Be a catalyst for teachers to think about <i>mathematics</i> in a different way • Be a negotiator for <i>mathematics</i> • Read professional literature on <i>mathematics</i> curriculum and instruction and reflect 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be a good listener • Coach teachers • Be aware of all the factors that play a part of curriculum • Attend and facilitate professional development opportunities related to <i>mathematics</i> education on local, state, and national levels • Be aware of district, state, and national <i>mathematics</i> expectations • Be passionate about <i>mathematics</i> and the importance of mathematics • Constantly learn about <i>mathematics</i> • Know what good <i>mathematics</i> teaching and instruction is • Realize how important it is for kids to get a really good foundation in <i>mathematics</i>

Challenges of MCL1.

Prior to enrollment in the mathematics curriculum leadership graduate degree program, MCL1 indicated that she was new to her role as a mathematics curriculum leader. MCL1 expressed a need for knowledge to better understand the structures and strategies for delivering information about mathematics content. MCL1 felt she needed

⁹ Per MCL1's Journal, Writing Responses, and Interviews

an understanding of the mathematics curricula across grade levels. In other words, “What might geometry look like across the [curriculum]? You know, what kinds of things might you expect kids to do at 3rd grade as opposed to 1st grade? What does maybe a strand look like?” (MCL1.Summer2005Interview). MCL1 also acknowledged that she was not always comfortable within her leadership role. She indicated a need to know how to facilitate mathematics professional development that is “more efficient and more effective” (MCL1.Summer2005Interview).

During the mathematics curriculum leadership program, MCL1 indicated that she had grown to have a better grasp of the mathematics curriculum across the district:

Well I think I have a better picture of that bigger view of mathematics instead of that little first grade view. We looked at mathematics even at the high school level and stuff and so I have a better view of that. I hope I was more effective. We have learned a lot of strategies and I hope my questioning got better over those past three years as I looked and thought about where kids are going and where they have come from. (MCL1.Spring2008Interview)

Although overcoming one hurdle, MCL1 continued to face challenges throughout the program concerning support and time.

When her roles and responsibilities shifted to working more with teachers, MCL1 had the opportunities to apply the leadership knowledge and abilities she developed in the program. Teachers saw her as the “go-to math person”, their “support system” (MCL1.Spring2008Interview). She revealed, “I have had very engaging conversations with a small group of people” (MCL1.Spring2008Interview). However, this was not the sentiment heard throughout the building. A new set of challenges existed for MCL1 as she was confronted with resistant teachers. The following statement illustrates the resistance that MCL1 experienced from two uncooperative teachers:

Both of them are very, not confrontational, because they really have no desire to hear what you have to say. So, I just think that they have made up their own decisions and you are not going to sway them. But I figure, if we don't let them in and if they are not invited in, then that gives them the impression that we have something that we want to hide or are ashamed of. I don't think that is true, so I have tried to really be open to these people not agreeing with me and there is really nothing to say to them that is going to change their mind. But, we do need to invite them in. (MCL1.Spring2008Interview)

Despite the teachers' resistance, MCL1 continued her effort to support such teachers and to seek out strategies for handling resistant teachers.

In addition to the challenge of resistant teachers, MCL1 acknowledged a lack of time to gain knowledge. For example, MCL1 admitted that she had difficulty finding the time to read professional literature. "I really haven't had a lot of time to sit down and really do some professional reading that I have really wanted to look more deeply into" (MCL1.Spring2008Interview). MCL1 sought to find time to read informally to assist her growth. Once completing the program, MCL1 continued to encounter challenges in the areas of support and knowledge.

MCL1 strove to seek the support of faculty members in her building. MCL1 reports that some teachers continued to be supportive of her, while others were not "a comfortable fit" (MCL1.Spring2011Interview). Many of the teachers thought she was there to "spy on them" or to "correct their teaching" (MCL1.Spring2011Interview). That was not her intention. Instead, MCL1 wanted to be welcomed into teachers' classroom to assist them in their teaching of mathematics.

After the program, MCL1 was under the direction of a new principal. She felt like she did not receive the support that she experienced from her previous principal. MCL1 notes, "I would like to have an administrator that's more aware really of what's going in the classroom and not just smile... and be supportive... to take that initiative to have

those kinds of conversation with me” (MCL1.Spring2011Interview). Having little support from some teachers and the principal left MCL1 without the desire to engage in necessary fights for the mathematics curriculum. However, MCL1 notes, “If I could just meet with my leadership team all the time, I’ll be more fired up because I leave there and I’m more energized, but that doesn’t happen as often as possible” (MCL1.Spring2011Interview). MCL1 feels that she still needs more knowledge on leadership. She has to learn when to hone in and share her knowledge of what’s best for kids. In addition, MCL1 wants to experience professional development that encourages her to speak on how to share knowledge of mathematics with others in a positive way because “it is easy to be negative these days” (MCL1.Spring2011Interview).

Participant MCL7

MCL7 had just completed 16 years of teaching when he entered the mathematics curriculum leadership degree program. He had taught fourth, fourth/fifth split, and fifth grade. MCL7 worked with fifth grade at a school where the student population was small. MCL7 believed that there were advantages and disadvantages to working at a school with this type of population. An advantage for MCL7 was that he knew all of the staff and students. One of the disadvantages was that one person would have to wear so many hats (i.e., after school mathematics club, after school geography club, student council, district committees, PTA executive board, partner in education, positive behavior support, technology committees).

MCL7 began his teaching career with mathematics utilizing his past experiences. MCL7 challenged himself to become better because he believed that “an appeal of teaching was the challenge to try to improve and get better... experience in the classroom

and educating yourself really helps you improve” (MCL7.Summer2005Interview). He further stated that self-reflection and sharing with other teachers helped him to grow and learn.

MCL7’s preparation and professional development opportunities.

MCL7 was from a rural town in the Midwest, where his school district attracted mostly teachers who had been educated in the same school district. MCL7 indicated that in this kind of situation “Your school really can’t grow and be diverse like you need it to be to prepare them [students] for the real world unless you can bring in, you know, people from different backgrounds” (MCL7.Summer2005Interview). MCL7 perceived his high school mathematics experience to be similar to that of the 1940s. The school district was always a few years behind the change that they said they were going through. MCL7’s first mathematics experience in college was different from that of his past. He felt as if the other students had gotten prepared through their high schools. He struggled at times, but managed to be successful. As a result, MCL7 received a Bachelor of Science in Elementary Education. Although he engaged in school and district professional development for teaching and learning mathematics, MCL7 did not participate in any professional development training for mathematics curriculum leadership.

During the program, MCL7 became aware of leadership skills for dealing more effectively with the school’s faculty. He also had the experience of writing a manuscript.

MCL7 articulated:

I have never done a research thing or anything in APA format. I had no idea about how to do that and I feel more confident with that. I think another thing is how I have always been a pretty good writer, but it has always been more reflection and life stories and never curriculum. Now I have been able to match those two together and that intrigues me. (MCL7.Spring2008Interview)

In addition, MCL7 praised the graduate degree program for its assortment of course instructors. He felt he gained so much from the different educators. The program allowed him to gain insight into the various issues at different grade levels. The class discussions over the assigned readings added depth to his knowledge.

Today, MCL7 is glad that he attended the graduate degree program. He gained confidence for standing up for what he believed in (e.g., mathematics). The program afforded him the opportunity to work with individuals who challenged him. MCL7 states, “They [the participants of mathematics curriculum leadership graduate degree program] were all fantastic. There wasn’t a poor course in all of the group...I made a lot of contact” (MCL7.Spring2008Interview). MCL7 also credits the program for allowing him the experience of writing his first publication. He is extremely excited about the response that he got from his publication. He acknowledges:

You know that’s amazing to me. It’s just like that blows me out of the water. Because here’s the funny thing about that, it had to be submittable, but you didn’t have to submit it, and so I was one of those people who was like yeah, yeah, well alright, but I’m not going to submit. And that moment that hit me was when, I always had my kids in a writing contest and they always say, “Well, do we have to do it?”. And I say, “you can’t win unless you submit” and then I got to thinking about the whole...I said man, am I not living out what I am trying...and so, and she had encouraged me several times to submit it and I was probably the last ones to do so. And, I said alright, I’ll submit it. And I just did that more out of guilt than anything. And then wow, it just took off. And so, it’s been a very positive thing. I would consider doing it again. (MCL7.Spring2011Interview)

That publication was a major highlight of the graduate degree program for MCL7.

However, MCL7’s involvement in the graduate degree program opened his eyes to many other opportunities as well. MCL7 states,

I loved it [the mathematics curriculum leadership graduate degree program]. I would love to see it followed up. I think that would be awesome. I really think that they should have that class again... I think that would be amazing. The level of academic teaching was fantastic. (MCL7.Spring2011Interview)

MCL7 earned a Master of Education in Curriculum and Instruction with an emphasis in Mathematics Education upon his completion of the mathematics curriculum leadership graduate degree program.

Roles and actions of MCL7.

Before entering the graduate degree program, MCL7 worked on many committees within the school, the district, and the community. MCL7 was the sponsor of the after school mathematics club, geography club, and student council. He was also a committee member for selecting the district's curriculum, revising the district's mathematics assessments, partner in education, PTA executive board, positive behavior support, and technology (see *Table 13*). This list could go on and on as witnessed by MCL7's statement, "Boy, I tell you what. You name it; I've about served on it at one time or another. So, there's a lot" (MCL7.Spring2008Interview).

Because of his commitment to the university program of study, MCL7 found that he no longer had sufficient time to engage in his previous activities. However, MCL7 added the responsibility of being a part of the mathematics vertical team at his school. This team would meet one morning a month to discuss the district's mathematics curriculum alignment with the statewide assessment test along with different mathematical strands (e.g., the algebraic reasoning factor). In addition, MCL7 had an informal role as a resource person with whom teachers in his building could communicate about mathematics. MCL7 desired to be a part of the district's mathematics leadership team.

Currently, MCL7 continues to speak highly of the work that the mathematics vertical team at his school accomplished. However, this team is no longer in existence, and so MCL7 does not have any formal roles as a mathematics curriculum leader. He states,

“Well, I like volunteering for those things. At least I feel like I have some input. I can take some ideas from our building, our faculty. And at least their voices are kind of heard” (MCL7.Spring2011Interview). He continues to support elementary mathematics curricular changes in his school and district. Although the district’s elementary mathematics curriculum may not be favored by many, MCL7 “can see positives and negatives of the curriculum change” (MCL7.Spring2011Interview). MCL7’s school decided to implement a “platoon” system in which he is currently responsible for teaching mathematics to all fifth graders in his school (MCL7.Spring2011Interview). He states,

What I love about teaching this year is that we are platooning. Platooning is departmentalization. So, I get to teach all 5th graders, which is really new. I’ve never been able to do that before. It’s always our class and then the other class. And so, you know, I am teaching the math and science and health.
(MCL7.Spring2011Interview)

Table 13¹⁰

MCL7’s Formal Roles

Mathematics Curriculum Leadership Roles as of 2005 (while teaching 5th grade)	Mathematics Curriculum Leadership Roles as of 2008	Mathematics Curriculum Leadership Roles as of 2011 (while teaching mathematics to all 5th grade)
<i>School-Level</i> Sponsor of After School Mathematics Club	<i>School-Level</i> Vertical Mathematics Team	<i>School-Level</i> Mathematics Teacher for 5th Grade
<i>District-Level</i> District Curriculum Committees, Revised District Mathematics Assessments	<i>District-Level</i> District Elementary Mathematics Leadership Team	<i>District-Level</i> District Elementary Mathematics Leadership Team
<i>Other-Level</i> N/A	<i>Other-Level</i> N/A	<i>Other-Level</i> N/A

¹⁰ Per MCL7’s Journal, Questionnaire, Writing Responses, and Interviews

MCL7's views of mathematics curriculum leadership.

MCL7 viewed mathematics curriculum leaders as he would any other leader. He suggested that a mathematics curriculum leader is someone who is a good communicator, open minded, good listener, has excellent people skills, hard worker, and supportive (see *Table 14*). A mathematics curriculum leader is going to put in the time and effort to do what it takes to succeed.

During the program, MCL7 viewed a mathematics curriculum leader as “being more than a teacher of teachers. It’s a bigger picture than that” (MCL7.Spring2008Interview). A mathematics curriculum leader was someone who was a listener, knowledgeable on many levels (e.g., the faculty, what’s going on, the mathematics curriculum), and a risk taker willing to try different approaches to different situations. The mathematics curriculum leader should respect the faculty, yet that respect has to be earned. MCL7 posits,

We have had a lot of coaches out here in literacy and math and I think that if you have not been in those shoes, it will be different. But, I think I have learned a lot simply by what not to do and seeing some of the things they did.
(MCL7.Spring2008Interview)

After the program, MCL7's views about mathematics curriculum leaders have shifted. MCL7 has an idea of “what a leader could be or what a leader should be” (MCL7.Spring2011Interview). His involvement in the graduate degree program allowed him to delve into “how to do that” (MCL7.Spring2011Interview). MCL7 views a curriculum leader as an individual who can “use your ears more than you do your mouth and you need to listen and your eyes too. Kind of see where people are coming from, what their ideas are. It’s not so much what you say, but how you say things that will help motivate others” (MCL7.Spring2011Interview).

MCL7 also views a mathematics curriculum leader as someone who is able to utilize the ideas of others. This person wants to improve instruction through curricular or teaching changes.

Table 14¹¹

MCL7's Views of Curriculum Leadership

Views of Curriculum Leaders in 2005	Views of Curriculum Leaders in 2008	Views of Curriculum Leaders in 2011
<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be a good communicator • Be a good listener • Be a hard worker • Be supportive • Have an open mind • Have excellent people skills • Put in the time and effort to do what it takes 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be a listener • Be a risk taker to try different methods • Be respectful of the faculty, but that has to be earned • Be knowledgeable on many levels (i.e., the faculty, what's going on, the <i>mathematics</i> curriculum) • Have a background of history and still be a leader of <i>mathematics</i> 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Use their ears more than their mouths • Utilize many viewpoints (i.e., their own, teachers) • Attend and facilitate professional development opportunities related to <i>mathematics</i> education on local, state, and national levels • Improve instruction through the curriculum, teaching, textbook selection, writing test questions, looking at how <i>mathematics</i> taught

Challenges of MCL7.

MCL7 sought knowledge of various mathematics materials, updates on current mathematics curricular trends and practices, and current technology. In addition, MCL7 dealt with an unsupportive school community as he stated:

We got a lot of cliques going on in our building and it's really not helping. I think our leadership has been a little lacking in our building as far as you know the role for a principal. He doesn't validate you very well. So, that's what I see in my building. (MCL7.Summer2005Interview)

During the graduate degree program, MCL7 faced the challenge of continuing to be an elementary teacher. He had toyed around with the idea of going to middle school, but

¹¹ Per MCL7's Journal, Writing Responses, and Interviews

he states, “I love what I do and I know that I am really good at it” (MCL7.Summer2005Interview). He was not willing to step down from being an elementary teacher because he would not be sure some of the things (e.g., vertical mathematics team, mathematics club) he had started would continue.

MCL7 does not think you can ever stop learning. However, MCL7 was ready to venture out and put some of the things he had learned into play (e.g., leadership skills). In doing so, MCL7 needed support from the faculty. He felt a lack of support from the principal and teachers. For example, MCL7 illustrates a discouraging moment in the following quote:

I got really discouraged one time with one of my vertical team meetings when only half of the members showed up. I was thinking, what did I do wrong? So, having somebody to springboard some ideas off of would be huge. So, some type of network for leadership that would help with what we should do in different roles. That would be great. (MCL7.Spring2008Interview)

Additionally, MCL7 needed time to sit down with other fifth grade teachers across the district to engage in mathematical discussions.

MCL7 has a new principal this school year and acknowledges that she is trying to find her way in this new position. However, after some time, MCL7 believes that his principal is able to share leadership with teachers. “I think she’s kind of realized what the strengths are of the individual teachers, so their background...She knows who to kind of bounce ideas off and a lot of times she’ll throw it out there and people will volunteer but a lot of times people kind of point that’s your person” (MCL7.Spring2011Interview).

Participant MCL3

MCL3 taught mathematics for 14 years at the secondary level including the sixth, seventh, eighth, and ninth grades. She taught in two school districts, with 12 years of

service in her current district. Before the program began, MCL3 saw about 127 eighth or ninth grade students daily. MCL3 admitted that her teaching had grown from “force-feeding” to assisting students in developing their own understanding of mathematics (MCL3.Summer2005Interview). She began to talk less. Instead, she spent most of her time listening to her students and asking questions to assist her students in making sense of their understandings and misconceptions.

In MCL3’s school, there are two district approved mathematics curricula being used. One curriculum is considered to be traditional; meaning one mathematical strand is the major topic for each course (e.g., an Algebra course, a Geometry course). The other curriculum is integrated, where students learn topics in algebra, geometry, and statistics together in the same course. MCL3 works with a principal who has a shared leadership perspective.

MCL3’s preparation and professional development opportunities.

Prior to her entrance into the program, MCL3 was engaged in professional development for secondary teachers offered by her school and district throughout the school year and summer. MCL3 spent a significant amount of time collaborating with colleagues about the district mathematics curricula. At the school level, there were two weekly 50-minute periods set aside for MCL3 and other members of the mathematics team to discuss various topics concerning the district’s mathematics curricula. They often met after school to continue those mathematical discussions.

At the district level, MCL3 participated in formal professional development programs. She and other mathematics teachers in the district attended sessions where the discussions were about the mathematics curricula. MCL3 facilitated many of these

discussions. Other professional development opportunities included moments where she met with colleagues outside of formal settings to converse about mathematics. However, MCL3 did not receive any formal training that was exclusively related to mathematics curriculum leadership. MCL3 hoped to gain knowledge about current research in mathematics curriculum, the mathematics content, and “best practices” in mathematics by entering the graduate degree program (MCL3.Summer2005Interview).

During the program, MCL3 had occasion to meet with current and future mathematics curriculum leaders. They exchanged ideas about mathematics curriculum and leadership. Such opportunities provided insight into facilitating mathematical discussions. MCL3 recalled a moment from one of her classes:

I think I learned this from your class to bite my tongue every time I want to say, “research says”... because they are sick of hearing that from me and that turns them off right there. But, I will share things and say I am going to have my kids work on one giant piece of paper because I want my kids to really collaborate. You know, just some instructional strategies or pieces about the algebraic thinking. So, I try to share things in little spurts here and there and sometimes I see teachers picking up on it and deciding to try that. A lot of times not, but that is ok. (MCL3.Spring2008Interview)

MCL3 acknowledged she had much to learn (i.e., knowledge about current research in mathematics curriculum, the mathematics content, and “best practices” in mathematics) during the program (MCL3.Spring2008Interview). MCL3 anticipated gaining knowledge applicable to her role as a teacher that would prepare her to take on leadership roles. Upon her completion of the program, MCL3 reported that the program influenced her in many ways as illustrated by this statement:

A lot of it is the confidence, knowing where to go to get information, a lot of knowledge about textbooks and curriculum, and how widely curriculum varies from state to state and nationally. Also, best practices and reading that research and being careful about research or what you’re really learning from that. ...the

desire to pursue some facet of that [research] all the time, especially during the summer when I try to renew and refresh. (MCL3.Spring2011Interview)

MCL3 earned a Master of Education in Curriculum and Instruction with an emphasis in Mathematics Education upon completion of the mathematics curriculum leadership graduate degree program. Following the program, she continues to be involved with professional development opportunities at her school and district. Many of the school level professional development opportunities are informal (e.g., sharing lesson ideas). Outstanding professional development opportunities continue to be available for teachers to collaborate in the district regarding mathematics. MCL3 was a part of a three-year professional development experience that focused on mathematics curriculum, instruction, and assessment. She also participated in workshops that concentrated on the curriculum and assessment in order to identify the essential skills for mathematics. In addition, MCL3 frequently participates in national professional development events including national conferences such as NCTM where she is able to hear national perspectives on curriculum. She has attended several sessions at the conferences that connected with what she was doing with her district's mathematics curriculum.

Roles and actions of MCL3.

Before the mathematics curriculum leadership graduate degree program, MCL3 taught mathematics to eighth and ninth graders. She also assumed mathematics curriculum leadership roles at the school level, the district level, and the state level (see *Table 15*). MCL3 performed many actions within these different capacities. She hosted student teachers of mathematics as well as pre-service mathematics teachers at various stages in their program of study. One unforgettable moment of leadership was when she coordinated a mathematics night at her school. Her responsibilities were to

organize the mathematics night and assist students in presenting mathematics discussions to their parents during which students had to lead their parents through a mathematics lesson.

MCL3 was also a member of the district's mathematics leadership team. She facilitated mathematical curricula discussions with teachers at her school, her district, and at a statewide conference.

Although engaged in the mathematics curriculum leadership graduate degree program, MCL3 continued teaching mathematics to eighth and ninth graders and experienced an adjustment in her roles and responsibilities. MCL3 took on the leadership role of the mathematics department chair during the 2006-2007 school year (see *Table 15*). As the mathematics department chair, MCL3 worked with nine teachers. The mathematics department consisted of six mathematics teachers and three teachers from the special education department. MCL3 communicated with members of the mathematics department regarding news from the district and what the district was doing with mathematics across all grades. In turn, MCL3 took information from her school's mathematics department to district meetings and meetings with other district mathematics chairs each month. In this role, MCL3 acted as the liaison between the mathematics department and the principal in which she was expected to do classroom observations of the mathematics teachers. This was not an evaluative role for her. Nevertheless, the observations were to be informative and serve as a part of the teachers' summative evaluations for the school year. In addition, as the mathematics department chair, MCL3 was expected to make recommendations about teaching assignments. She continued to be a part of the district's mathematics leadership team. In this role, she facilitated

mathematics discussions at her school and the district during the school year and in the summers.

Upon completion of the program, MCL3 continued to serve as the mathematics department chair at her school and as a member of the district’s mathematics leadership team (see *Table 15*). She continued to observe mathematics teachers in her building and facilitate mathematics discussions. MCL3 was afforded the opportunity to work closely in a shared leadership role with eighth grade mathematics curriculum leaders. As a team, they designed the district’s mathematics curricula. MCL3 continued to teach eighth and ninth grade mathematics. Many of the actions she performed in the earlier years of her career, she continued (e.g., facilitating meetings, attending meetings, observing). However, she didn’t work with as many student teachers because there weren’t as many candidates for the program.

Table 15¹²

MCL3’s Formal Roles

Mathematics Curriculum Leadership Roles as of 2005 (while teaching secondary mathematics)	Mathematics Curriculum Leadership Roles as of 2008 (while teaching secondary mathematics)	Mathematics Curriculum Leadership Roles as of 2011 (while teaching secondary mathematics)
<i>School-Level</i> Partner Mathematics Teacher	<i>School-Level</i> Department Chair	<i>School-Level</i> Department Chair
<i>District-Level</i> District Mathematics Curriculum Leadership Team	<i>District-Level</i> District Mathematics Curriculum Leadership Team	<i>District-Level</i> District Mathematics Curriculum Leadership Team
<i>Other-Level</i> University Advisory Committee	<i>Other-Level</i> N/A	<i>Other-Level</i> N/A

¹² Per MCL3’s Journal, Questionnaire, Writing Responses, and Interviews

MCL3's views of mathematics curriculum leadership.

At the beginning of the program, MCL3 identified qualities of mathematics curriculum leaders including patience, knowledge, passion, honesty, and being a good listener (see *Table 16*). MCL3 felt that mathematics curriculum leaders should lead by example, continually try to improve their practice and knowledge, suggest and promote opportunities to talk about mathematics lessons, and do mathematics lesson studies. Mathematics curriculum leaders should take advantage of every opportunity to learn, share their knowledge, and be willing to question what they have done. Mathematics curriculum leaders should also have discussions about what mathematics looks like for students and how to involve students in mathematics discussions. Just as significant, mathematics curriculum leaders do not have to have all the answers.

MCL3 viewed mathematics curriculum leaders similarly to what she did before entering the mathematics curriculum graduate degree program. She continued to believe that mathematics curriculum leaders should be patient, knowledgeable about the mathematics curriculum and current research on mathematics education; thus, they should be continual learners. These persons must be proactive and willing to stand up for mathematics education, even when they feel like no one is listening. However, as MCL3 became a mathematics department chair, she adds that being a mathematics curriculum leader is not always pleasant. MCL3 believed there are times when you will have to stand up for what is best for kids learning mathematics. She asserted that a mathematics curriculum leader should have people skills and a sense of humor since being a leader is not always going to be pleasant.

Presently, MCL3 thinks that a mathematics curriculum leader is someone who is knowledgeable about the mathematics curriculum, but not necessarily an expert. This person keeps abreast of what is going on with the mathematics curriculum. He/she knows what is coming down the pike. He/she communicates this knowledge of the mathematics curriculum to others (e.g., teachers, principals, other curriculum leaders) in their building, district, or with a national audience. This person should enjoy being the mathematics curriculum leader. Additionally, a mathematics curriculum leader should attend and facilitate professional development activities related to mathematics education on local, state, and national level.

Table 16¹³

MCL3's Views of Curriculum Leadership

Views of Curriculum Leaders in 2005	Views of Curriculum Leaders in 2008	Views of Curriculum Leaders in 2011
<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be a good listener • Be honest • Be knowledgeable • Be passionate • Be patient • Lead by example • Share their knowledge • Be willing to question what you've done • Continually try to improve their practice and knowledge • Know it's ok to not have all of the answers • Take advantage of every opportunity to learn • Suggest and promote opportunities to talk about <i>mathematics</i> lessons and do <i>mathematics</i> lesson studies • Have discussions about what <i>mathematics</i> looks like for students and how to involve students in <i>mathematics</i> discussions 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be patient • Be a continual learner • Be willing to put their money where their mouth is • Have people skills and a sense of humor • Know that a <i>mathematics</i> curriculum leadership is not always going to be pleasant • Knowledgeable about the <i>mathematics</i> curriculum and current research on <i>mathematics</i> education • Be proactive and willing to stand up for <i>mathematics</i> education 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Attend and facilitate professional development opportunities related to <i>mathematics</i> education on local, state, and national levels • Be knowledgeable about the <i>mathematics</i> curriculum, but not necessarily an expert of the curriculum • Communicate their knowledge of the <i>mathematics</i> curriculum with others (i.e., teachers, principals, other curriculum leaders) in their building, district wide, or with a national audience • Enjoy being the <i>mathematics</i> curriculum leader

¹³ Per MCL3's Journal, Writing Responses, and Interviews

Challenges of MCL3.

Before the mathematics curriculum leadership graduate degree program, MCL3 expressed a need for knowledge and support. She wanted to learn strategies for not telling students, but instead assisting them in gaining an understanding about mathematics. MCL3 also desired a support system of colleagues to work toward finding solutions in mathematics that would help students learn. She posited, “I really needed that support and that opportunity to talk with my colleagues about math, and what we might think the kids would say or question or misconceptions in order to deal with that” (MCL3.Summer2005Interview). Such collaborations would include opportunities to brainstorm with colleagues about mathematical questions to pose to students.

Once involved in the mathematics curriculum leadership graduate degree program, MCL3 experienced a shift in her leadership roles, resulting in a continued need for knowledge and support. MCL3 expressed that she would like to gain knowledge about current research centered on the mathematics curricula, increase her knowledge of various strands of the mathematics content, and learn “best practices” in mathematics teaching. MCL3 needed additional knowledge in her new role as mathematics department chair. After her first year in the graduate degree program, MCL3 asserted a need for the following (MCL3.WS.CurriculumLeadership.062206):

- Leadership skills
- Confidence in knowledge
- Knowledge of mathematics
- Knowledge of the group you are teaching—beliefs and understanding
- Knowledge of curriculum
- Current research
- What individuals want/need from a leader
- Effective communication
- Knowledge of pedagogy

- Empowering others
- Dealing with conflict
- Awareness of strategies for dealing with resistance
- Strategies to deal with conflict
- Knowledge of self and strategies for dealing with different personalities
- Curriculum implementation knowledge and resources
- Building community at the secondary level in mathematics (resources)
- Accountability for pursuing a professional growth plan for leadership
- Mathematical knowledge (algebra and geometry strand, number-sense)

MCL3 also needed time to continue to participate in professional development opportunities to assist her with the different knowledge bases of a leader. In addition, MCL3 continued to express the view that support from colleagues was important and necessary.

In 2011, MCL3 talked about how she is able to take many strategies from the program to enhance her leadership actions. She referred to these strategies as “tools in her tool box” (MCL3.Spring2011Interview). Such tools for MCL3 included strategies for dealing with conflict, knowledge, and confidence. She affirmed how the program provided her with strategies in the following citations:

It gave me some tools to calm down, and go back and say that didn't go well, and you know, I'm still learning to not take some of that stuff personally and to disengage from the real negative that can come out of that. So, again I would go back to the tools in my toolbox to deal with those challenges, you know just some of those... It has more to do with the leadership.

Well, it let me know that I had important things to say and important things to be heard and that you didn't have to be an expert. You just had to be...had to be a learner and you had to have skills to promote that learning not only for you but for others. It was more about that being a learner than you're the expert mathematician than you know. Confidence! Confidence to pursue roles that I would be interested in. (MCL3.Spring2011Interview)

However, MCL3 continues to experience challenges in the areas of support, knowledge, and time. She feels a need to learn how best to share information and when to share information. She often hits a roadblock when she tries to share needed information with

teachers. MCL3 experiences personality conflicts with teachers who are against change in the mathematics curricula. MCL3 tries to move forward in a more positive direction. In trying to present teachers the opportunity to work on their knowledge of the mathematics curricula, she finds time is an obstacle. She declares, “It’s tough, a lot of challenges” (MCL3.Spring2011Interview).

Participant MCL5

At the time of MCL5’s enrollment in the graduate degree program, she was a secondary mathematics teacher with seven years experience teaching grades ten through twelve. MCL5 decided to teach mathematics because she was good at it. She recalled, “I was good at pushing around symbols” (MCL5.Summer2005Interview). When MCL5 began her teaching career, she used two curricula types. One curriculum integrated strands of mathematics (e.g., algebra, geometry) during the course. The other curriculum employed a traditional mathematics approach in which one mathematical strand is the major topic for that course (e.g., an Algebra course, a Geometry course). MCL5 went about teaching mathematics procedurally. She soon altered her teaching style to conceptual methods. Such a shift allowed MCL5 to be a voice in her mathematics community (the school and the university).

MCL5’s preparation and professional development opportunities.

MCL5 received her masters in educational administration before becoming a part of the mathematics curriculum leadership graduate degree program. She also received preparation through her commitments as a member on various committees (i.e., school executive council, statewide assessment test committee chair, statewide assessment test mathematics item writer, university/school study group). MCL5 decided to be a part of

the program because she was interested in mathematics curricula and being an instructional leader along with wanting to help with school academic improvement.

During the program, MCL5 believed that the reading assignments assisted her growth in understanding different aspects of mathematics. This contributed to her being “well-versed” in mathematics (MCL5.Spring2008Interview). Her participation in the program paid off as she assumed the position of assistant principal.

MCL5 attended the NCSM 2006 conference during the graduate degree program. At the conference, MCL5 met mathematics educators who increased her knowledge of various research they had been involved with. She gained knowledge of professional learning communities. Further, MCL5 was able to match thoughts about ethnic socio-economic issues with ideas related to equity. She admits:

I hadn't really paid much attention to this issue before—mostly because I felt unequipped to discuss what I thought equity was about—ethnic socio-economic issues. I learned that equity is just the issue I've been thinking about—every student (and teacher, and school) having access to our stuff. At the school level, this is a big issue for students, but I feel it's even a bigger issue for districts and states. This issue is on my mind a lot. (MCL5.Spring2008Interview)

Years later, MCL5's involvement in the mathematics curriculum leadership graduate degree program afforded her the opportunity to better understand the national discussions regarding mathematics curriculum development. She posits, “I didn't necessarily see the necessity or the avenue to become a part of the national conversation”

(MCL5.Spring2011Interview). She credits the program with assisting her in knowing where the mathematics conversations were being held (e.g., conferences). She is able to access information and people to aid her in moving forward with mathematics. She believes being active in mathematics education is important. Finding a community of mathematics teachers and leaders is important and something she “took most from the

graduate degree program” (MCL5.Spring2011Interview). MCL5 received an Educational Specialist Degree in Mathematics Education, which was considered an emphasis area as she works to become a principal.

Roles and actions of MCL5.

Before the program, MCL5 had leadership roles where she served as a committee member and chair of the state’s high stakes exam, the statewide assessment test (see *Table 17*). She assisted in creating mathematics items for this test. She participated in a research study group with the university and her school district to better understand the district’s mathematics curriculum. MCL5 also coordinated the master school schedule with the guidance office, while teaching mathematics to secondary students.

During the graduate degree program, MCL5 experienced a shift in her role and responsibilities. MCL5 no longer impacted secondary students directly. She became a member of the administrative team, namely assistant principal. As a member of the administrative team, MCL5’s time was spent performing the duties of athletic director (see *Table 17*). In this role, MCL5 sent emails and made telephone calls for coordinating and organizing sports related activities and other miscellaneous duties. The remaining time was spent carrying out leadership duties. MCL5 would observe mathematics classrooms twice a week. She would also meet with the principal twice during the week for usually an hour to an hour and a half. MCL5 had several meetings with others along the way that she labeled as “quick meetings” in which she found herself to be a soundboard for the teachers, coaches, and even parents (MCL5.Spring2008Interview).

After the mathematics curriculum leadership graduate degree program, MCL5 retained her role as assistant principal, continuing to spend the majority of her time as the

athletic director (see *Table 17*). She also performed actions as the evaluating principal for the mathematics team and the building operations administrator. However, she cautions that there is very little time for working as a mathematics curriculum leader. Other obligations pull her away from this role. MCL5 desires to become a building principal, and she believes that could increase her involvement in mathematics curriculum leadership.

Table 17¹⁴

MCL5's Formal Roles

Mathematics Curriculum Leadership Roles as of 2005 (while teaching secondary mathematics)	Mathematics Curriculum Leadership Roles as of 2008	Mathematics Curriculum Leadership Roles as of 2011
<i>School-Level</i> School Executive Council	<i>School-Level</i> Assistant Principal,	<i>School-Level</i> Assistant Principal,
<i>District-Level</i> N/A	Evaluating Principal for the Mathematics	Evaluating Principal for the Mathematics
<i>Other-Level</i> MAP Committee Chair and Mathematics Item Writer, University Study Group	Department <i>District-Level</i> N/A <i>Other-Level</i> N/A	Department <i>District-Level</i> N/A <i>Other-Level</i> N/A

MCL5's views of mathematics curriculum leadership.

MCL5 described a mathematics curriculum leader as an individual who's likeable and trustworthy (see *Table 18*). This person is methodical about how he/she leads the department. The mathematics curriculum leader sets priorities and works on these priorities one item at a time until all are taken care of. This person is able to multi-task between mathematics curriculum issues and leadership. This person doesn't give up on the team. He/she is in it for the long haul. The mathematics curriculum leader works with the teachers to identify objectives that need to be done for the school and the department.

¹⁴ Per MCL5's Journal, Questionnaire, Writing Responses, and Interviews

MCL5's vision of what a mathematics curriculum leader remained very similar to her views at the beginning of the program. However, she did add that a mathematics curriculum leader should be a listener, a researcher, and a politician. He/she has to know who to talk to and how and be able to time it all just right. He/she needs to be patient, yet urgent. A mathematics curriculum leader needs to be empathetic since MCL5 feels this is a trait that gets lost in leadership.

Upon completion of the program, MCL5's vision of a mathematics curriculum leader did not change. MCL5 believes that the capacity for leadership is in all teachers. She posits this idea in the following:

You can be a math curriculum leader without thinking differently about it, but in my mind we could probably all do the status quo without having many curriculum leaders because everyone is kind of, you know how you grew up in mathematics... So, we can teach the same way fairly easy without a lot of leadership needed. (MCL5.Spring2011Interview)

In addition, MCL5 adds that a mathematics curriculum leader needs to be a part of the national discussions. A mathematics curriculum leader should be a continual learner of mathematics curricula and instill that passion within other teachers, thus practicing what we preach.

Table 18¹⁵

MCL5's Views of Curriculum Leadership

Views of Curriculum Leaders in 2005	Views of Curriculum Leaders in 2008	Views of Curriculum Leaders in 2011
<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be likeable • Be trustworthy • Be methodical about how they lead • Set priorities and works these priorities one item at a time until all is taken care of issues and leadership • Not give up on the team (they're in it for the long haul) • Work with the teachers to identify objectives and what needs to be done for the school and the department • Be able to multi-task between <i>mathematics</i> curriculum, issues, and leadership 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be a listener • Be a politician • Be a researcher • Be patient, yet urgent • Be empathetic because this is a trait that gets lost in leadership • Be knowledgeable about who to talk to and how and be able to time it all just right 	<p><i>MCLs should:</i></p> <ul style="list-style-type: none"> • Be a part of the national discussions • Practice what we preach • Be continual learners of <i>mathematics</i> curricula • Instill a passion for <i>mathematics</i> with other teachers

Challenges of MCL5.

MCL5 sought a formal role as a mathematics curriculum leader. As such, MCL5 desired knowledge to assist her in this quest. In particular, MCL5 wanted to know more about the NCTM's *Principles and Standards for School Mathematics* and the state's grade level expectations. MCL5 remembered learning about the NCTM's *Principles and Standards for School Mathematics* as an undergraduate student, but she was not able to make connections at that time. She also recalled how the standards were used when she was working on statewide assessment test items for mathematics. MCL5 states:

I was in on writing some of the questions this year for the '07 [statewide assessment] test...The *Principles and Standards* influence our state standards...Just kind of seeing how they really push math education reform I

¹⁵ Per MCL5's Journal, Writing Responses, and Interviews

appreciate them [NCTM's *Principles and Standards for School Mathematics*] a lot more now. (MCL5.Summer2005Interview)

MCL5 remained frustrated by the sheer volume of the NCTM's *Principles and Standards for School Mathematics*. As a result, she wanted the opportunity to discuss the standards. She would use this knowledge in designing the school's mathematics courses. In addition, MCL5 sought to have a better grasp for facilitating discussions around mathematics. She desired to have meaningful mathematics discussions that yield a product.

MCL5 gained a better understanding of the NCTM's *Principles and Standards for School Mathematics* while in the graduate degree program. She became a "fan":

I guess lately I have been thinking about the gap between those of us who have spent a tremendous amount of time thinking about the [NCTM's] Principles and Standards, not in and of themselves but their impact, and the need to improve instruction and student achievement in the area of mathematics and the gap between us and those who spend very little time thinking about it.
(MCL5.Spring2008Interview)

MCL5 thinks that the standards are the right direction for mathematics curricula, but she explains that the logic behind the NCTM's *Principles and Standards for School Mathematics* is very difficult to explain to individuals (e.g., family members) who feel very secure in their own education.

Now that the program has ended and MCL5 has become an assistant principal, she is no longer involved in weekly discussions about mathematics teaching and learning.

However, being current in those discussions is still a concern for her.

Findings Across the Mathematics Curriculum Leaders

In the sections above, I presented findings related to the four components of the framework displayed in *Figure 3*, professional development, roles/actions, views, and

challenges, for each of the seven participants. In the following sections, I present the results from analyzing the data across the seven participants. Specifically, I discuss themes that emerged from the data for each of the four major components in the framework (as seen in *Table 19*) in relation to the research question: *How did participation in the mathematics curriculum leadership graduate degree program influence participants' views about leadership, leadership roles, and actions in relation to these leadership roles?*

Table 19

The Graduate Degree Program's Influence on Mathematics Curriculum Leaders

Components	Themes
Professional Development	<ol style="list-style-type: none"> 1. The mathematics curriculum leaders developed specialized knowledge about curriculum and leadership. 2. The mathematics curriculum leaders desired additional learning experiences beyond the life of the program.
Views	<ol style="list-style-type: none"> 3. The mathematics curriculum leaders changed their views of leadership. <ol style="list-style-type: none"> a. The mathematics curriculum leaders recognized the importance of broader perspectives beyond their own contexts. b. The mathematics curriculum leaders recognized that leadership is not limited to formal positions. c. The mathematics curriculum leaders' perception of the qualities that leadership requires changed. 4. The mathematics curriculum leaders' perception of themselves as leaders changed. <ol style="list-style-type: none"> a. The mathematics curriculum leaders viewed themselves as leaders. b. The mathematics curriculum leaders' confidence grew. 5. The mathematics curriculum leaders' perception of how others viewed them as leaders changed.
Roles/Actions	<ol style="list-style-type: none"> 6. The mathematics curriculum leaders assumed new leadership roles and responsibilities. 7. The mathematics curriculum leaders approached situations differently. <ol style="list-style-type: none"> a. The mathematics curriculum leaders interacted with people in ways that would build relationships and address conflict using different strategies. b. The mathematics curriculum leaders thought through decision making in new ways in which they recognized the importance of listening and reconsidered the role of "telling." c. The mathematics curriculum leaders recognized the importance of using their voices. 8. The mathematics curriculum leaders drew on support from others in the graduate degree program.
Challenges	<ol style="list-style-type: none"> 9. The mathematics curriculum leaders recognized new challenges that leadership efforts introduced. <ol style="list-style-type: none"> a. The mathematics curriculum leaders experienced lack of support. b. The mathematics curriculum leaders experienced time constraints.

The mathematics curriculum leaders' professional development opportunities.

Prior to entering the graduate degree program, the seven participants had a great deal of experience participating in professional development activities. These activities primarily focused on teaching and learning mathematics (e.g., sessions or book studies that addressed specific mathematical topics, mathematics curricula, or topics such as the achievement gap or assessment). However, they did not participate in professional development specific to mathematics curriculum leadership or leadership in general. Although the participants had not attended formal preparation related to leadership, they had begun to assume leadership roles and responsibilities in their district. In addition, they were interacting with principals, teachers, parents, and other leaders about critical issues in their schools and district. As they began to facilitate professional development for other teachers and attend vertical team meetings with teachers from other grade levels, they recognized that they did not have the curricular knowledge that they needed to participate in these conversations. Thus, they desired more formal preparation that examined mathematics curriculum leadership. MCL6 captured this sentiment that many of the participants expressed:

See that's why I'm in this program. I want to know how I should be organizing. I want an understanding of the developmental process for kids. You know, why do we teach something at this point, instead of maybe earlier or later so that, that's what I don't have the knowledge to do. I definitely want it to be kid friendly, where they have the control of it. Gosh, I don't know. I think that's one of my desires, is what I want to learn...I need a lot more cross-grade level type things, I think. I feel like I know my curriculum pretty well now, I hope I do since I'm responsible for training new people, but I really want to know more about, especially like even 3rd and 5th would be enough I think to start with to, what are they coming in with and where are they supposed to go? I mean that conversation. And I've had a few opportunities that computational fluency that we did I think it started out we were split K-2 and 3-5, but the district mathematics coordinator combined us. And that I mean it's just amazing to see what they're doing in kindergarten and how that builds all the way up to what my kids are doing. So

that's, I think that's what my strongest desire is right now. As far as leadership, I'm kind of, this facilitator of the math leadership team but I need somebody to help me know where to lead everybody else and that type of thing. And to make the decisions of what we should do, what we should focus on, things like that. I don't have the confidence to say, "Okay this is what our building needs." I definitely want to have somebody to bounce things off of.
(MCL6.Summer2005Interview)

During and following the mathematics curriculum leadership graduate degree program, the participants described how the program influenced their knowledge bases beyond the teaching and learning of mathematics. After analyzing the data that was specifically coded for professional development for all seven participants, the following two themes emerged:

Theme 1: The mathematics curriculum leaders developed knowledge about curriculum and leadership.

Theme 2: The mathematics curriculum leaders desired additional learning experiences beyond the life of the program.

Theme 1: The mathematics curriculum leaders developed knowledge about curriculum and leadership.

Involvement in the mathematics curriculum leadership graduate degree program provided opportunities for the participants to develop specialized knowledge that they enacted in their contexts, not only while they participated in the program, but also several years later. In the following two sections, I discuss knowledge related to mathematics curricula and leadership that the participants developed as a result of the program.

Mathematics curricula knowledge.

Prior to the mathematics curriculum leadership graduate degree program, the participants expressed a need to develop knowledge about mathematics content, knowing how mathematical ideas develop over time, and how mathematics content is presented in

mathematics curriculum materials across grade levels. One participant expressed a desire for more mathematics knowledge, “knowledge in my content area, just more mathematics, and the mathematics behind lessons” (MCL3.Summer2005Interview). Other participants shared desires to know specific mathematical strands across grade levels to handle curricular issues:

I really am more interested in looking kind of more overviews, like what does computational fluency look like? What might geometry look like across the curriculum? You know, what kinds of things might you expect kids to do at 3rd grade as opposed to 1st grade? What does a strand look like across [grade levels]? (MCL1.Summer2005Interview)

I would like to look first of all, how is probability being taught throughout because I don't know all of the K-5 curriculum. I don't know it that well. Where is it being taught and then I would try to find out are those teachers teaching that or is it they never get to it cause it's a matter of time or because they don't have a good comfort level, they just glaze the top surface so you never have that depth of understanding with kids ever going on. That would be my first question. Or maybe if the grade level is being tested the kids have not had enough exposure to it, it's really an unfair question and at that point then you have to make adjustments to your curriculum. (MCL2.Summer2005Interview)

Prior to entering the program, the participants desired knowledge of the mathematics curriculum at different grade levels, scope and sequence of the mathematics curriculum, and learning progressions in mathematics as demonstrated above. Furthermore, this desire continued upon completing the program:

Really now, I think about what the middle school math looks like. Personally, my middle school math was just a series of units. So, to know more about what they do and what they want kids to know to help prepare in the elementary grades, like the algebraic thinking part and when that shift comes into more of the algebra kind of stuff. I would like to know more about that. (MCL6.Spring2008Interview)

The participants stated that they knew more about the mathematics and mathematics curriculum as a result of their participation in the leadership graduate degree program. For example, MCL2 articulated, “I think I'm more knowledgeable about what division

looks like across the grade bands...I have a better idea across the curriculum, what things might look like, across the program” (MCL2.Spring2011Interview). As such, the participants developed a broader view of mathematics curriculum and began to think about curriculum materials across strands and across grade levels.

In addition to learning about mathematics curriculum at different grade levels, the participants learned about student thinking at different grade levels. For example, MCL3 became familiar with strategies to support students’ algebraic thinking based on students’ written or oral explanations. MCL6 also shared this sentiment, “The content stuff we did, like the algebraic thinking we did, that really opened everybody’s eyes. Even the importance of the equal sign, it just raised an awareness of some of the content that I didn’t know” (MCL6.Spring2008Interview). Subsequently, MCL6 was able to ask better questions to make connections and extract mathematical thinking from her students. MCL4 was able to examine students’ mathematical needs closely as she realized, “We are not just teaching all kids the same because they are not the same” (MCL4.Spring2008Interview). She now looks for ways to support her students as individuals. MCL1 concurred with MCL4 adding, “You kind of have to look at everybody as individuals and you have to think about where they came from, where are they going, what will work with that person and how far can you push that person” (MCL1.Spring2008Interview). The participants in the cohort recognized that this new knowledge about how students think at different grade levels would not only enhance their own mathematics teaching, but also strengthen their conversations with colleagues in other classrooms and during professional development as teachers inquired about how to help specific children learn mathematics.

MCL3 added that the graduate degree program provided opportunities for her to gain “knowledge about textbooks and curriculum, and how widely curricula vary from state to state and nationally” (MCL3.Spring2011Interview). The graduate degree program helped MCL1 “to be more global in [her] process” (MCL1. Spring2011Interview) as the participants discussed current issues and trends related to mathematics curricula in the program. They examined historical documents and standards related to curriculum as well as debated issues such as should there be a national mathematics curriculum. For example, they addressed issues such as social justice, teaching, learning, assessment, technology, and curriculum materials and standards, while they examined *A Nation At Risk*, NCTM’s *Principles and Standards for School Mathematics*, and NCTM’s *Focal Points*. As a result of the program, the participants’ knowledge about mathematics curriculum materials, standards, and issues expanded beyond just their local materials, standards, and issues. Moreover, with this expanded knowledge base, their views about leadership broadened beyond their local context, as will be discussed later.

In addition, the faculty in the program encouraged the participants to get involved with national organizations and to attend conferences to further develop and strengthen their knowledge bases. Some of the participants did not have these experiences prior to entering the program. As they began to attend conferences, they were thrilled with the knowledge they gained. Furthermore, these experiences helped them develop professional networks with other leaders around the country. For example, MCL5 explained that she knew people who were involved in national conversations about mathematics curriculum based on what she had read. She wanted to participate in national conversations about mathematics curriculum, but she did not know how to enter

those conversations. As she began to attend national conferences, she interacted with other, more experienced leaders who helped her gain access to these types of conversations as well as information and people. She acknowledged that being aware of those conversations and being active in them would be important for her role as a leader.

Mathematics leadership knowledge.

Prior to entering the graduate degree program, the participants were asked about the type of knowledge they would like to develop while in the program. Typically, their responses focused on knowledge that would help them become better teachers of mathematics in their own classrooms, rather than on knowledge that would help them become curriculum leaders outside their classrooms. In fact, many of the participants could not identify specific knowledge related to leadership that they needed to develop. For example, during the initial interview one participant stated,

I think they're pretty large in the leadership thing just because I have not had any development there. So, I don't know, I would say that's pretty wide open. Give me what you got. (MCL3.Summer2005Interview)

However, during the graduate degree program, the participants acquired new leadership roles and responsibilities, which required new knowledge, competencies, and strategies. For example, the mathematics curriculum leaders desired knowledge for addressing conflicts with their colleagues. MCL6 articulated this in her spring 2008 interview, "I would still like to learn more about handling the conflict and the hard stuff."

MCL1 shared this need:

That whole idea about change and how different people react to that and how you can make that professional development and change happen for them is so important. But you need to still understand and value who they are. That is really like a tightrope. You have to maintain that relationship. If that relationship is destroyed, then those opportunities for them to learn and grow are probably also going to be compromised. But, how do you know? It is just the same with kids.

When do you nudge and when do you back off? When is enough, enough? When do you just say, now is not the time and walk away. Not walk away, but you think about how that didn't work and what can I try. How can you reach everybody? I guess my big ah-ha is everyday; kids walk in and we expect them to be learners. But, teachers walk in everyday and we don't expect them to be learners. That was a big ah-ha for me. (MCL1.Spring2008Interview)

In order to be more effective in their new positions, the mathematics curriculum leaders required knowledge working with adult learners, specifically in the context of conflict.

Faculty in the mathematics curriculum leadership graduate degree program engaged the participants in opportunities to discuss and "role play" situations related to leadership including conflict (MCL2.WS.CommunityBuilding.062206). MCL6 recapped an influential moment during the graduate degree program:

The leadership pieces, all the role-playing, and scenarios and stuff like that, and the personality styles were huge. That fit in very nicely with some of the stuff we did with cognitive coaching also and how it affects how you approach people or try to deal with people. So that was big. (MCL6.Spring2008Interview)

Other participants added these thoughts as to how the mathematics curriculum leadership graduate degree program supported their growth:

The leadership and how to work with other people has probably been the very best part of that. Also, having some tools and some ideas about where to start and how to work with other people who have different ideas than I do. (MCL1.Spring2008Interview)

It [the mathematics curriculum leadership graduate degree program] gave me some tools to calm down, and go back and say that didn't go well, and you know, I'm still learning to not take some of that stuff personally and to disengage from the real negative that can come out of that. (MCL3.Spring2011Interview)

It [the mathematics curriculum leadership graduate degree program] helped you understand how conflict works and you really can work through that with someone and not, I'm not a confrontational kind of person and that really probably scared me the most about that position. (MCL2.Spring2011Interview)

In addition, the graduate degree program was a vehicle that presented the participants with opportunities to discuss research that would further enhance their leadership development. This knowledge was welcomed by the participants as captured by MCL2,

Knowledge about resources that are available. Just knowing, instead of just talking off the top of your head your opinion, that sometimes your opinion has more weight if you can seek out some valid research to go with what you are thinking. (MCL2.Spring2008Interview)

Throughout the program, the participants completed ongoing surveys and writing prompts to document growth and limitations of their leadership development. An analysis of these documents indicated that the participants developed knowledge to:

- Help them understand how people might react
- Help them understand how they might work through things with people
- Ask better questions to help teachers make connections
- Be aware of their audience
- Be the best decision maker for the group
- Have a more critical eye to better predict how teachers might react or teachers might use curriculum materials
- Work through some curriculum issues
- Manage groups
- Work through conflict
- Deal with adult learners

All the participants recognized the knowledge that they developed as a result of their participation in the program. This was specialized knowledge beyond mathematics and mathematics teaching that supported their efforts in working with adults outside their classrooms.

Theme 2: The mathematics curriculum leaders desired additional learning experiences.

Upon completion of the graduate degree program, the participants commended the program organizers for the knowledge that they developed. As such, the program left a lasting footprint on the participants. The mathematics curriculum leaders desired

additional learning experiences beyond the life of the program. Participants explained that they found themselves selecting literature to read to help them gain further understanding of “how students think and achieve in mathematics”

(MCL1.Spring2011Interview). One participant recapped her schedule since the program,

Last year and even in prior years, I just never have sat down and just read a book about kids’ learning, unless it was for a class or something. Last year somehow, and I don’t know how I came across it, I came across a book called something about the global achievement gap. (MCL1.Spring2011Interview)

MCL6 shared, “There’s fabulous literature out there. [Need] time to read it, and study it, try it out. You know, I would love to keep taking classes and stuff and learning”

(MCL6.Spring2011Interview). Another participant spoke about professional development activities she had attended since the program ended, “I had attended and done some reading on grading and have very much been trying to move towards standards-based grading” (MCL3.Spring2011Interview). MCL6 shared how she tries to keep up with national literature,

What keeps coming to mind is research and reading research and trying to stay up on it more than I was ever aware of before. So, I think that is going to have an impact along the way. I am not going to let things kind of happen, you know? Like, the national math panel results came out and I went and read them. How many classroom teachers have done that? (MCL6.Spring2008Interview)

Still, participants desired continual professional development opportunities that would assist them in keeping abreast of current issues in mathematics education.

Additionally, some participants “just wish that the program would expand” because it would be beneficial for other teachers (MCL4.Spring2011Interview). MCL4 stated,

[The mathematics curriculum leadership graduate degree program] would be purposeful because [teachers] get into so many master’s program where it’s not purposeful and where that is not as much about the math than it is about the collaboration, how to be a leader among your team, and you know, how to be a thinker, and know where to go to get assistance.

MCL7 shared,

You know, I loved it [the mathematics curriculum leadership graduate degree program]. I would love to see it followed up. I think that would be awesome. I really think that they should have that class again, program through there. I think that would be amazing. The level of academic teaching was fantastic. I loved working with the grad students. They really added to that. It was like a huge thing for me. And there's one way that kind of influenced me, and I'll kind of leave at this. I had the opportunity, it kind of came through the email the other day, a grad student coming in for science this year. And because of my experience with that I said yeah, absolutely. But I don't know if I would have done that if I hadn't had the experience. (MCL7.Spring2011Interview)

After completing the program, the participants expressed a desire to learn more research-based strategies they could use to support teachers and students.

For example, one participant stated, "I would like to be stronger in those research based intervention strategies that everybody says we have to use"

(MCL6.Spring2008Interview).

The mathematics curriculum leaders' views.

Upon completion of a cross-case analysis of the seven participants, it was evident that the mathematics curriculum leadership graduate degree program influenced participants' views about leadership as follows:

Theme 3: The mathematics curriculum leaders changed their views of leadership.

Theme 4: The mathematics curriculum leaders' perceptions of themselves as leaders changed.

Theme 5: The mathematics curriculum leaders' perceptions of how others viewed them as leaders changed.

I discuss each of these themes and related sub-themes in the following sections.

Theme 3: The mathematics curriculum leaders changed their views of leadership.

The mathematics curriculum leaders changed their views about leadership in three different ways. They recognized the importance of a broader view of mathematics education beyond their own classrooms and schools. They recognized that leadership is not limited to formal positions, but also involves informal roles and responsibilities. In addition, the mathematics curriculum leaders' perceptions about the qualities that leadership requires changed. I present data in the following three sections to elaborate on these changes.

The mathematics curriculum leaders recognized the importance of a broader view beyond their own classrooms and schools.

The participants' views of leadership before the program were tied to formal positions or responsibilities they had observed or experienced in their schools and district. For example, the participants spoke of their experiences serving on the district elementary leadership team or mentoring beginning teachers. Only one participant spoke about her involvement presenting lessons to faculty from other school districts (MCL2.Summer2005Interview). Similarly, when the participants spoke about leadership roles that they desired in the future, they identified positions they had observed in their district. For example, MCL4 stated, "I would like to be in the classrooms of others, I would really like to work in classrooms with other teachers" (MCL4.Summer2005Interview). Two other participants spoke about being a math coach and another participant addressed the idea of being a mathematics department chair in the long future.

If I could do anything, I would love to be a math support teacher where I would just go into classrooms and support teachers and kids.
(MCL1.Summer2005Interview)

I think I would love to be a math coach —someone that would go around and help people just with their math. (MCL6.Summer2005Interview)

Down the road I see myself as department chair within my building.
(MCL3.Summer2005Interview)

Prior to the graduate degree program, the participants did not identify leadership work that they desired outside their schools and district. The program faculty pushed them to consider alternative perspectives outside of their classrooms as well as themselves.

As such, the mathematics curriculum leaders experienced shifts in their views about leadership. The mathematics curriculum leaders no longer limited their views to their classroom or district levels. They realized that their views needed to span beyond their classrooms. One mathematics curriculum leader explained,

It's not just about the 26 kids in my room, it's about all of the fifth graders across the district and all of the teachers and all of the needs because every school we know has different needs... Not always going right back to your place where you go everyday, but thinking about that big picture. (MCL2.Spring2011Interview)

The participants recognized the importance of a broader view beyond their own classrooms. MCL2 stated, "I have the better background and can think more broadly about those issues" (MCL2.Spring2011Interview). MCL1 said, "It [the mathematics curriculum leadership graduate degree program] helped me to be more global in my process" (MCL1.Spring2011Interview), while MCL4 shared, "I began to see things from other people's perspectives and that my way wasn't the right way and it [the mathematics curriculum leadership graduate degree program] really made me realize that" (MCL4.Spring2011Interview).

As the leaders expanded their views beyond their classrooms, they began to recognize the value of examining curricula at different levels. For example, MCL1 stated:

We looked at curriculum from different countries. We looked at it from the aspect of a national [perspective]. For example, the push for a national curriculum, looking at all of those from different facets that come into play. It helped me to be more global in my thinking, to think more before I talk.
(MCL1.Spring2011Interview)

While MCL3 also explained:

Being able to look at the state documents, the district documents, the national documents and know where they are coming from in a bigger rim and in that [graduate] program we read a lot of research and always knowing where is this information coming from, keeping in mind even a textbook.
(MCL3.Spring2011Interview)

Adding to MCL3's thoughts, MCL6 shared:

So that was big. Just looking at things on a national scale, like [one faculty member] pushed us in all of her classes and she kept us up to date on the National Clearinghouse and all those entities out there that are influencing public reactions and stuff. She really pushed us to stay on top of things like that. I would have been very content staying in my local, tiny bubble, but she made us look broader. (MCL6.Spring2008Interview)

As demonstrated in the quotes above, the participants acknowledged that these experiences in the graduate degree program influenced their views of leadership and what they thought about as they engaged with others.

Another change noted by one participant was related to her views of the NCTM's *Principles and Standards for School Mathematics*. When asked about her view of this national document upon entering the program, MCL3 replied, "I would disagree with most of them" (MCL3.Summer2005Interview). However, MCL3 became a "fan" of the NCTM's *Principles and Standards for School Mathematics* as a result of the graduate degree program (MCL3.Spring2008Interview). While other participants made vague, positive statements about the *Principles and Standards for School Mathematics* in the

opening interviews, it was obvious it was not a resource they referenced or understood. However, this view changed as a result of the program. MCL2 began to use the document at every chance she could. “I guess it has become one of my number one references. If I am not sure what direction to go, then I often refer to that [the NCTM’s *Principles and Standards for School Mathematics*]” (MCL2.Spring2008Interview).

The mathematics curriculum leaders recognized that leadership is not limited to formal positions.

When the participants entered the program, they only recognized formal roles and responsibilities of mathematics curriculum leaders. For example, when the participants were asked about their leadership roles and responsibilities, most of their responses focused on participation on committees or serving as a mentor for pre-service or beginning teachers. They did not identify informal leadership responsibilities such as dealing with a conflict through a conversation with a teacher in the hallway or working with colleagues to create curriculum or assessment. MCL3 stated,

I feel like I’ve been a leader, but it’s never been necessarily in the sense of a role that’s been defined as a leader... Because I think there’s a difference between, you know, when you ask me what roles have I filled as a leader I mean I think it’s more just by what I do, by action, by what I do and choose to do.
(MCL3.Summer2005Interview)

This quote illustrates the idea that many of them talked about—that they needed someone in authority such as a school or district administrator to designate or assign them official leadership roles and responsibilities rather than initiating them themselves.

Upon completion of the graduate degree program, some of mathematics curriculum leaders also identified informal leadership roles and responsibilities, indicating a change

in their views of what type of activities were considered leadership. For example, MCL2 stated:

I don't think I would have really thought, oh, I've worked on writing a task or the assessments for the district. Those kinds of things, I don't know if I would have thought, "Oh, I do math leadership kinds of things" because it was really more informal. It wasn't really, oh would you do this or you know, you are on this committee or that committee. I see the definition more broadly than I did (MCL2.Spring2011Interview).

When asked about the leadership roles that MCL1 had assumed, she began with a question and then proceeded to answer the question in terms of both formal and informal leadership.

Do you mean informally or formally? ... Well, most importantly, I am the kindergarten bus teacher at the end of the day. The kids go, "there is my bus teacher". I think people see me as the go-to math person. If they have a question about mathematics or a kid that they cannot figure out, that is probably how they see me first, even more than supporting in the classroom. It is kind of that, I am not sure what is going on with this kid so could you help me figure that out, type of person. In the class, people are pretty open to me coming in. Some really just are very comfortable with me just sitting there and not interacting very much and just being an observer. Then other people are just like, "chime in" or, "would you like to teach a lesson?" I don't really think they see me so much as a resource. I am not sure people over here have very many questions about their teaching mathematically. I think many people in this building are very happy where they are as a mathematics teacher. I mean, there are a few, and I have had very engaging conversations with a small group of people, but I would say the majority of people in this building do not really see their mathematics teaching as some place they really would feel comfortable going and changing drastically... I have done some PD and collaboration days... I have done professional development. I am on the AFL [Assessment for Learning] team for our building. I am on the Special Ed math team. (MCL1.Spring2008Interview)

The quotes of MCL2 and MCL1 were representative of the participants' view of informal roles of leadership. As a result of their participation in the graduate degree program, the participants' views of leadership expanded to include informal roles and responsibilities.

The mathematics curriculum leaders' perceptions of the qualities that leadership requires changed.

Prior to the graduate degree program, participants were asked to describe the qualities of curriculum instructional leaders and to identify specific curriculum instructional leaders in their buildings to help them identify qualities. Typically, the participants focused on general qualities such as curriculum leaders are knowledgeable, likeable, hardworking, trustworthy, and supportive and identified their principals as the curriculum instructional leaders in their buildings rather than teachers. When asked about the qualities of an instructional curriculum leader MCL3 described them in the following:

Number one you have to be a very good listener. I think you know whether you're the teacher, or somebody presenting, or facilitating a group whatever that group may be. You have to really be a good listener, and I think you have to be honest if you don't know, then you need to say you don't know. You need to be able to listen to someone and connect that to something... Whether it be mathematics or an idea, you know to build on that, to think on your feet.
(MCL3.Summer2005Interview)

Table 20 displays a summary of participants' views of curriculum leaders before they began the program in 2005, at the completion of the program in 2008, and three years after their graduation from the program.

Table 20¹⁶

Participants' Views about Qualities of Curriculum Leaders

Views of Curriculum Leaders in 2005	Views of Curriculum Leaders in 2008	Views of Curriculum Leaders in 2011
<p><i>Curriculum Leaders should:</i></p> <ul style="list-style-type: none"> • Be a hard worker • Be experienced • Be willing to take risks • Be likeable • Be methodical about how they lead • Be patient • Be passionate • Be supportive • Be trustworthy • Be a good communicator • Be a positive role model • Have an open mind • Have excellent people skills • Be knowledgeable • Share their knowledge • Be willing to learn • Continually try to improve their practice and knowledge • Be willing to question what you've done • Be very good at questioning people to draw out of them what they believe and what they know • Accept and value different learning styles • Have the ability to see the big picture • Work with the teachers to identify objectives and what needs to be done for the school and the department • Not give up on the team (they're in it for the long haul) • Set priorities and works these priorities one item at a time until all is taken care of • Be able to multi-task between <i>mathematics</i> curriculum issues and leadership • Suggest and promote opportunities to talk about <i>mathematics</i> lessons and do <i>mathematics</i> lesson studies • Advocate <i>mathematics</i> for students 	<p><i>Curriculum Leaders should:</i></p> <ul style="list-style-type: none"> • Be hard working • Be a listener • Be a risk taker to try different methods as far as how to approach different situations • Be patient, yet urgent • Be motivated • Be a politician • Be a researcher • Be a continual learner • Be able to share • Be accepting • Be empathetic • Be flexible • Be in teachers' classrooms • Have people skills • Have a sense of humor • Have an understanding of adult learners • Have an understanding of the dynamics of change • Have an understanding of various communication styles • Have the "best" grasp of the content • Be respectful of the faculty, but that has to be earned • Have a "toolbox" of strategies for facilitating discussions so that participants feel empowered to express themselves • Be knowledgeable about who to talk to and how and be able to time it all just right • Be knowledgeable on many levels (i.e., the faculty, what's going on, the <i>mathematics</i> curriculum) • Be confident to lead and support teachers with the <i>mathematics</i> curriculum • Be proactive and willing to stand up for <i>mathematics</i> education • Be a catalyst for teachers to think about <i>mathematics</i> in a different way • Have a background of history and still be a leader of <i>mathematics</i> • Know that <i>mathematics</i> curriculum leadership is not always pleasant • Read professional literature on <i>mathematics</i> curriculum and instruction and reflect • Understand best practices in <i>mathematics</i> • Understand the different <i>mathematics</i> curricula (including nontraditional versions) • Understand the <i>mathematics</i> standards • Attend and facilitate professional development opportunities related to <i>mathematics</i> education on local, state, and national levels • Advocate <i>mathematics</i> for students 	<p><i>Curriculum Leaders should:</i></p> <ul style="list-style-type: none"> • Coach teachers • Be a good listener • Include ALL individuals • Practice what we preach • Be aware of all the factors that play a part of curriculum • Utilize many viewpoints (i.e., their own, teachers) • Instill a passion for <i>mathematics</i> with other teachers • Be aware of district, state, and national <i>mathematics</i> expectations • Be confident to lead and support teachers with the <i>mathematics</i> curriculum • Be continual learners of <i>mathematics</i> curricula • Be knowledgeable about the <i>mathematics</i> curriculum, but not necessarily an expert of the curriculum • Enjoy being the <i>mathematics</i> curriculum leader • Improve instruction through the curriculum, teaching, textbook selection, writing test questions, looking at how <i>mathematics</i> is taught • Attend and facilitate professional development opportunities related to <i>mathematics</i> education on local, state, and national levels • Advocate <i>mathematics</i> for students

¹⁶ Per Participants' Journal, Writing Responses, and Interviews

As shown in the table, the nature of the qualities identified after the program in 2008 and 2011 differed from their initial views of the qualities of a curriculum leader in 2005. The leaders continued to identify general qualities (e.g., good listener), but also used more specific descriptions (e.g., the type of knowledge a leader needed) as well as specific ideas related to mathematics (e.g., understand the mathematics standards). For example, in 2005, MCL6 described a mathematics curriculum leader as someone who should (MCL6.Summer2005Interview):

- Be able to communicate (“the people skills”)
- Be very good at questioning people to draw out of them what they believe and what they know
- Encourage
- Have an understanding of the developmental process for kids
- Have the ability to see the big picture

Over time, a mathematics curriculum leader was no longer described as just being knowledgeable and hard working, but instead, this individual is knowledgeable about mathematics content, mathematics curricula, and mathematics policies. He/she is not only aware of mathematics standards and policies at the local level, but also at the state and national levels. This individual knows how to work with adult learners. MCL6 shifted her views of a mathematics curriculum leader in 2008. She explained that a mathematics curriculum leader should (MCL6.Spring2008Interview):

- Be knowledgeable about how to work with students and be able to share that effectively with colleagues
- Have a “toolbox” of strategies for facilitating discussions so that participants feel empowered to express themselves
- Have an understanding of adult learners
- Have an understanding of the dynamics of change
- Have an understanding of various communication styles
- Have the “best” grasp of the content
- Make sure kids are having the best mathematical opportunities to develop into the best mathematicians
- Understand best practices in mathematics

- Understand the different mathematics curricula (including nontraditional versions)
- Understand the mathematics standards

In 2011, MCL6 expanded on these ideas to include that a mathematics curriculum leader should (MCL6.Spring2011Interview):

- Attend and facilitate professional development opportunities related to mathematics education on local, state, and national levels
- Have confidence in their leadership abilities

Moreover, the participants recognized that their positions as mathematics curriculum leaders were not always going to be pleasant. As such, they needed to be “proactive and willing to stand up for mathematics education,” “put their money where their mouth is,” and “[have] a sense of humor” (MCL3.Summer2008Interview). In addition, they used much stronger language to describe some of the general qualities in 2008 and 2011. For example, they used terms such as politician, catalyst, researcher, and proactive. The responses displayed in *Table 20* demonstrate their expanded views of leadership as a result of their participation in the graduate degree program.

Theme 4: The mathematics curriculum leaders’ perceptions of themselves as leaders changed.

The participants not only changed their views about the necessary qualities of mathematics curriculum leaders in general, but also changed their views about themselves as leaders. In the following sections, I describe changes related to: a) how they began to view themselves as leaders; and b) how they experienced growth in confidence.

The mathematics curriculum leaders viewed themselves as leaders.

In the beginning, the mathematics curriculum leaders identified different leadership roles that they had assumed (e.g., member of district Mathematics Leadership Committee, mentors for beginning teachers) as well as their leadership responsibilities (e.g., facilitate mathematics professional development for teachers in the district). However, they did not recognize all their leadership roles or acknowledge that they were leaders in a variety of situations. They did not initiate leadership activities related to mathematics curriculum and thought that type of activity would have to be sanctioned by someone in authority. However, upon the completion of the program, some participants began to expand their views of themselves as leaders. MCL4 admitted, “I don’t think I ever really knew the qualities of a leader and how much it took” (MCL4.Spring2008Interview). She goes on to explain,

You [the faculty member who taught the leadership classes] changed me. I mean that the leadership class and knowing that you can make a difference. I think we feel more empowered, knowledgeable, like we are able to step up and be leaders because we do have more knowledge and we have had that instruction.

MLC3 admitted,

It is so different, I noticed, to be a leader and talk to other leaders about what you are thinking, whether they agree with you or not, rather than go into a group that you think will all roll their eyes at you. It is very different.
(MCL3.Spring2008Interview)

On another note, MCL7 took the initiative to start and lead a group of teachers at his school. He explained in the following quote: “I also told him [the principal] that I was going to start the vertical team next year and that I was going to lead that”

(MCL7.Spring2008Interview). As a result of the program, the participants began to truly

view themselves as mathematics curriculum leaders who were empowered to initiate leadership activities.

The mathematics curriculum leaders confidence grew.

Confidence was another change that the mathematics curriculum leaders identified as a result of their participation in the program. Prior to the graduate degree program, the mathematics curriculum leaders felt uncomfortable about and avoided awkward situations that involved conflict and resistance. Moreover, they would solicit support from their district mathematics curriculum coordinator or principal before they engaged in unfamiliar territory (e.g., facilitating a mathematical strand discussion or starting a mathematics group at their schools).

After their participation in the graduate degree program, the participants acknowledged a boost in their confidence. The following statements illustrate this growth:

- I felt like it made me a better teacher because it made me a better thinker. It made me really question what I was doing and why I was doing it and if it was right, if it was benefitting everybody. (MCL4.Spring2011Interview)
- It made me be a better team-leading member because I became a better listener. And I began to see things from other people's perspectives and that my way wasn't the right way and it really made me realize that. (MCL4.Spring2011Interview)
- I have viewed myself as confident, but now I feel a different type of confidence. (MCL2.Spring2008Interview)
- I have never done a research thing or anything in APA format. I had no idea about how to do that and I feel more confident with that. (MCL7.Spring2008Interview)
- I feel like I had a say. I provided feedback on the revised GLE's. I sent something off to the state department. I don't think they listened to what I had to say, but I sent it at least and that was more than I ever would have done before. (MCL6.Spring2008Interview)

Thus, the participants gained confidence in their knowledge, in their ability to be assertive in different situations, and in their writing abilities. MCL6 shared the confidence she gained from writing,

Being pushed in our writing and the fact that I may have an article published is pretty cool... That has been a great opportunity that I would have never initiated on my own. I needed that push and I remember being very nauseous when [the faculty member in the program] mentioned it. (MCL6.Spring2008Interview)

When questioned about writing a second paper she responded positively and shared,

I am. I have been trying to collect some ideas and stuff. So that was really neat to grow like that. (MCL6.Spring2008Interview)

This confidence not only facilitated willingness to initiate leadership activities, but also prompted some participants to apply for formal leadership positions:

I think I would have not taken the math coaches job if I hadn't have done it [the mathematics curriculum leadership graduate degree program] because I wasn't feeling prepared just as a teacher. But with the background in curriculum and leadership and with some more math background, I felt more confident. (MCL4.Spring2008Interview)

Theme 5: The mathematics curriculum leaders' perception of how others viewed them as leaders changed.

During the interviews in 2011, the mathematics curriculum leaders shared information regarding resistance they experienced as they assumed new leadership roles. For example, MCL1 recalled a moment when she was a mathematics coach and the pairing with certain teachers was not ideal:

There were some times where I was assigned to work with a teacher, and it just wasn't a good fit. I think they thought I was in there to spy on them or correct... That was not my intention. (MCL1.Spring2011Interview)

In another instance, MCL2 talked about the resistance she also faced as a mathematics coach:

Probably when people not wanting you to be around or come to their room or feeling threatened...It's not that I'm ever in there because I think someone is not a good teacher. I'm in there because I want the best for kids and I think if we work together that's how you get the best for kids... It's not about a personal judgment about anyone. (MCL2.Spring2011Interview)

MCL2 continued to share, "some people felt threatened by me and thought she thinks she knows a lot about math."

Although the participants worried about some of the teachers' negative perceptions of them, they also described positive perceptions of others they interacted with following their participation in the graduate degree program. For example, MCL2 explained how her principal approached her about issues related to mathematics:

I think that my administrator comes to me if she knows there's a math opportunity or you know or say, "Oh this is going to happen, are you interested in doing that kind of thing?" (MCL2.Spring2011Interview)

MCL1 stated that she was viewed as the "math guru" in her building, where other teachers would approach her with questions that required her mathematics curriculum and teaching expertise (MCL1.Spring2011Interview). MCL5 explained that she was now viewed as a resource as the following quote illustrates,

I'm looked to as somewhat of a resource, but the identification as a resource for math curriculum is much tied to my experiences as a teacher here. (MCL5.Spring2011Interview)

One leader was reminded of her role as mathematics coach, which had ended by the time of the follow-up interview. MCL4 shared:

I was the math coach. They do still come to me, but I'm not the math coach anymore. They'll come up and really say, "I've got this kid and what about this". Actually the first grade teachers that I worked with quite a bit as math coach just a couple of hours ago and said, "hey, would you come teach the triangle lesson". (MCL4.Spring2011Interview)

MCL6 was referred to as the "math lady." She shared (MCL6.Spring2011):

I think in that role, they still come to me asking questions, they still ask me where to find some supplies, or can you help me make this or that. So, they still see me in the [math coach] role even though I don't have that much flexibility.

I get emails a lot from people just saying, you know, what does this mean. A fifth grade teacher asked, "Why do they name a plane with three points?" I don't know off the top of my head, but I'll find out, I got resources that I can go to...I don't have that title anymore that even looking at the last staff meeting we had, I still did a little presentation and shared some personal experiences. I mean, I think that I am still seen that way.

Whenever we are having a conversation in staff meetings or something else, and if I say something about math, people respect that because people know that I put a lot of my time and energy into math.

MCL7 described how others approached him about joining a team he was leading:

I had a really successful year. I had teachers in each grade level who volunteered to the point [where] at the end they were saying, "Can I join that, too?" It was really a successful year. (MCL7.Spring2011Interview)

MCL3 described how teachers approached her as an authority to make decisions in the absence of an administrator:

Well it is not designed to be that way, but they [other teachers] always come to me for permission if they don't want to meet that day because they have other things going on. So, it is not assigned and not meant to be, but I can tell they want to ok it. (MCL3.Spring2008Interview)

The mathematics curriculum leaders' perceptions of how others viewed them changed.

They became the "go to" mathematics support persons in their buildings with informal titles such as the "math resource", "math guru", and "math lady." They perceived that others knew they had specific knowledge and authority to answer questions or make decisions about mathematics curriculum leadership as a result of their participation in the graduate degree program and their additional leadership roles related to mathematics.

The mathematics curriculum leaders' roles and actions.

The mathematics curriculum leadership graduate degree program influenced the leadership roles that participants assumed as well as their leadership actions. After analyzing the data for the mathematics curriculum leaders' roles and actions, the following three themes emerged:

Theme 6: The mathematics curriculum leaders assumed new leadership roles and responsibilities.

Theme 7: The mathematics curriculum leaders approached situations differently.

Theme 8: The mathematics curriculum leaders drew on support from the others in the graduate degree program.

Theme 6: The mathematics curriculum leaders assumed new leadership roles.

Before the graduate degree program, participants had assumed a variety of leadership responsibilities at the school, district, and state levels. At the school level, some of the participants led book studies, hosted pre-service teachers from a local university, mentored novice teachers, and facilitated mathematics discussions during collaboration days. At the district level, all of the participants, with the exception of the assistant principal, were involved in the district mathematics teams for their various grade levels. In this role, they performed actions such as facilitating mathematical discussions related to their mathematics curriculum materials and analyzing the results of district assessments. However, the participants did not consider these types of activities as leadership, but rather just things that good teachers do. For most of them, they attributed this to their seniority at their respective schools and the relationships they had with their principals and district mathematics curriculum coordinators. MCL2 demonstrates this in the following quote:

I've kind of been at school awhile and done some different leadership opportunities. I guess so I'm looked at sometimes to do that by the principal, which is fine with me. (MCL2.Summer2005Interview)

MCL3 shared a similar instance in which she attended a mathematics workshop in place of the district mathematics supervisor who had a previous engagement. (MCL3.Journal)

Although these responsibilities were valued experiences, the participants also desired more formal mathematics curriculum leadership positions when they entered the graduate degree program. One participant stated, "Down the road, I see myself as department chair, within my building" (MCL3.Summer2005Interview). Other participants desired positions of supporting teachers with their mathematics, as the following statements indicate:

If I could do anything, I would love to be a math support teacher.
(MCL1.Summer2005Interview)

I would really like to work in classrooms with other teachers.
(MCL4.Summer2005Interview)

I think I would love to be a math coach. (MCL6.Summer2005Interview)

After the graduate degree program began, the district began to consider the possibility of creating mathematics coach positions at the K-7 level. MCL7 recalled, "The thought of math coaches came up and then we could kind of see that there maybe what they're looking to kind of build in the district and all that. I think that was an excellent idea" (MCL7.Spring2011Interview). Eventually, the district decided to create positions for mathematics coaches. Four of the seven participants opted to apply for the positions and eventually became mathematics coaches during the graduate degree program (see *Table 21*). The mathematics coaches supported teachers by modeling mathematics lessons, facilitating mathematics discussions, and assessing students' mathematical abilities. The

mathematics coaches felt the graduate degree program was definitely worthwhile and prepared them for the mathematics coach positions, as illustrated by MCL4 and MCL2's statements:

I would not have ever wanted to have done it [being a mathematics coach] without that program. (MCL4.Spring2011Interview)

So, a lot of that we talked about as far as leadership, and I would say, there was lots of things about the graduate degree program that I loved, lots of things. That probably helped me the most was the leadership part of it [the mathematics curriculum leadership graduate degree program]. (MCL2.Spring2011Interview)

The other three participants assumed new mathematics curriculum leadership roles as well. The remaining elementary teacher continued to work with students directly and held a mathematics curriculum leadership role as head of the vertical mathematics team for his school. The junior high school teacher became a mathematics department chair. In this role, the participant continued to work with students while supervising mathematics teachers. The high school teacher became an assistant principal. Her responsibilities included evaluating mathematics teachers regularly, but she no longer taught mathematics to students. These three participants expressed a similar sentiment that the mathematics curriculum leadership graduate degree program prepared them for their leadership positions.

Table 21¹⁷*Mathematics Curriculum Leader (MCL) Demographic Data as of 2011*

Mathematics Curriculum Leader	Years of Educational Services	Areas/Grades Taught	Graduate Degree Prior to the Graduate Degree Program	Graduate Degree Resulting from the Graduate Degree Program	Mathematics Curriculum Leadership Roles (Before the Program)	Mathematics Curriculum Leadership Roles (During and After the Program)
MCL 1	26	Elementary Teacher: Kindergarten, 1 st , 2 nd , 3 rd , 5 th , and 6 th	Master of Education in Curriculum and Instruction; Early Childhood Education	Educational Specialist in Mathematics Education	<i>School-Level</i> Fellows Mentor <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> N/A	<i>School-Level</i> Fellows Mentor, Mathematics Coach, Mathematics Teacher for 5th Grade, Special Education Mathematics Team <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> N/A
MCL 2	29	Elementary Teacher: 1 st , 1 st grade self-contained, 2 nd , 3 rd , and 5 th	Master of Education in Curriculum and Instruction; Reading	Educational Specialist in Mathematics Education	<i>School-Level</i> Mathematics Initiative Team <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> University Advisory Committee	<i>School-Level</i> Mathematics Initiative Team <i>District-Level</i> Mathematics Coach, District Elementary Mathematics Leadership <i>Other-Level</i> MCTM Elective Board, Host Teacher for Pre-service Elementary Teacher, Interview Team for Mathematics Education Positions
MCL 3	14	Secondary Mathematics Teacher: 6 th , 7 th , 8 th , and 9 th	N/A	Master of Education in Curriculum and Instruction; Learning and Instruction in Mathematics	<i>School-Level</i> Partner Mathematics Teacher <i>District-Level</i> District Mathematics Leadership Team <i>Other-Level</i> University Advisory Committee	<i>School-Level</i> Department Chair <i>District-Level</i> District Mathematics Leadership Team <i>Other-Level</i> N/A
MCL 4	27	Elementary Teacher: Kindergarten, 1 st , 2 nd , 3 rd , and 4 th	Master of Education in Curriculum and Instruction; Mathematics	Educational Specialist in Mathematics Education	<i>School-Level</i> Vertical Mathematics Team <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> N/A	<i>School-Level</i> Mathematics Coach <i>District-Level</i> N/A <i>Other-Level</i> N/A
MCL 5	13	Secondary Mathematics Teacher: 10 th , 11 th , and 12 th	Mathematics Master of Educational Administration	Educational Specialist in Mathematics Education	<i>School-Level</i> N/A <i>District-Level</i> N/A <i>Other-Level</i> MAP Committee Chair and Mathematics Item Writer University Study Group	<i>School-Level</i> Assistant Principal, Evaluating Principal for the Mathematics Department <i>District-Level</i> N/A <i>Other-Level</i> N/A
MCL 6	22	Elementary Teacher: Kindergarten – 8 th for deaf students, 2 nd , 3 rd , 4 th , and 5 th	Master of Education in Special Education; Learning Disabilities	Educational Specialist in Mathematics Education	<i>School-Level</i> Building Leadership Team, Building Math Team <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> N/A	<i>School-Level</i> Mathematics Coach <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> N/A
MCL 7	22	Elementary Teacher: 4 th , 5 th	N/A	Master of Education in Curriculum and Instruction; Learning and Instruction in Mathematics	<i>School-Level</i> Sponsor of After School Mathematics Club <i>District-Level</i> District Curriculum Committees, Revised District Mathematics Assessments <i>Other-Level</i> N/A	<i>School-Level</i> N/A <i>District-Level</i> District Elementary Mathematics Leadership Team <i>Other-Level</i> N/A

¹⁷ Per Participants' Applications and Interviews

The participants who work in secondary schools continue to hold the mathematics curriculum leadership roles that they assumed during the program; a mathematics department chair and an assistant principal. Due to budget constraints, the district's mathematics coach positions were eliminated, and these four participants returned to the classroom. However, they continue to be a part of the district mathematics leadership team and/or have many informal encounters with teachers and principals, as described above. In addition, the participants have assumed stronger roles in mathematics curriculum leadership. For example, two of the participants now teach mathematics to all fifth grades in their elementary schools, moving to a departmental model that did not exist when the program began. One participant also noted that she now works on the Response to Intervention district committee while another participant sought grants to support her school.

In addition to assuming more roles and responsibilities, participants also noted that they were better able to support mathematics teachers at their schools as a result of the graduate degree program. The graduate degree program was the "tool" that they needed to obtain knowledge and experiences, and learn strategies that would support their efforts (MCL3.Spring2011Interview).

All of the participants supported other teachers in their schools and districts, but four of them also authored peer-reviewed articles for national journals to support teachers in other schools across the nation as a result of their participation in the program. MCL6 recapped this experienced:

I wouldn't have ever been published had I not been there. I resisted it all the way, but she [faculty member who taught in the program] kept saying, "You can do this, you can do this." I did. So, lots of professional experiences that I had that I never would have had otherwise. (MCL6.Spring2011Interview)

Theme 7: The mathematics curriculum leaders approached situations differently.

The graduate degree program influenced how the mathematics curriculum leaders approached situations. The participants report that their interactions with teachers and principals were more relational so that they could engage others in conversations that would address issues and challenges. They dealt with conflict using different strategies and thought through the decision making process in new ways. They recognized the importance of listening and reconsidered the role of “telling.” They also considered broader perspectives as discussed above, recognized the importance of using their voices, and sought professional literature to inform their actions. These changes from the participants will be illustrated in the following sections.

The mathematics curriculum leaders interacted with people in ways that would build relationships and address conflict using different strategies.

The new roles that the mathematics curriculum leaders assumed had their share of responsibilities as mentioned above. Yet, the way the mathematics curriculum leaders approached situations that arose in these roles shifted. Prior to the graduate degree program, the mathematics curriculum leaders sought support from others (e.g., district supervisors or principals) to handle situations that they did not feel comfortable approaching (e.g., presenting arguments for initiatives to support teachers or avoiding conflict with others). For example, MCL7 would not approach his principal if he wanted to initiate an improvement in mathematics teaching and learning in his school. Instead, “I would probably get some support from [the district mathematics supervisor], and say, hey, this is what I’m wanting to do, what do you think?” (MCL7.Summer2005Interview). He goes on to explain that his principal is not always open to change. As such, MCL7

would consult with the district mathematics supervisor to “avoid problems” with his principal. After the graduate degree program, MCL7 admitted confronting his principal about efforts to help teachers in his building with teaching and learning mathematics. He shared, “I told him that I was going to start the vertical team next year and that I was going to lead that. I told him that I guess the proof will be in the pudding. So I guess that is why he showed up for the first couple of meetings... He has thanked me and told me that it was a very powerful discussion” (MCL7.Spring2008Interview). MCL7 was able to address the issue of confronting his principal with mathematics improvement efforts for teachers, thus building a better working relationship with the principal.

The mathematics curriculum leaders avoided conflict with teachers prior to the graduate degree program. When MCL2 was asked during the initial interview how she would respond to resistant teachers, who try to get others off task, she replied:

Well, that’s really tricky because adult learners, you can’t do the things you do in a classroom, they don’t always work, you know like proximity, touch on the shoulder and all that kind of stuff. You know if they’re interrupting at that point, that’s not going to work. So, that’s really hard. I mean I had some people when I did [some professional development]. Some people did that. I was always appalled. Teachers are the worst. I’m trying to think, put that in perspective because that’s really hard. Well, one, I would try to quickly get into some kind of an activity where people are working with each other and there’s not one person, you know, there’s not that opportunity where I’m talking and you continue to talk and people are looking at you or trying to listen to me, where it was clear if we could move quickly into some kind of activity to distract all the attention from that person. (MCL2.Summer2005Interview)

Yet, during her 2008 interview, MCL2 had a strategy to handle this person. She responded:

Well, at first you move by that person. You choose some kind of discussion thing and you make them your partner. Because if they continue to be off task, they are going to be off task. But, if you restructure it where they don’t have the opportunity to be off task or to draw people off. If you know they are a quasi leader socially, then you have assigned seating and mix it up and make it into a

game or something. But you purposefully try to kind of try break that group up with that person who might lead other people off task. So, there are things you can do, but you have to plan for it.

MCL2 did not back down from the resistant teacher. Instead, she was able to use strategies she had learned from the graduate degree program. MCL4's approach to conflict was slightly different from MCL7 and MCL2. While MCL4 tried to redirect conflict by asking questions prior to the graduate degree program, she too responded to the conflict differently upon the completion of the graduate degree program. She described an instance as follows:

And a teacher came up to me last night... We can have really good discussions about math... and she's a spitfire and I used to back down and say no confrontation. I don't like confrontation and so now it's kind of like, this is fun and we are learning a lot by this. And she goes, "I know we don't always agree, but you know I love you". I go, I know you don't always have to agree with me. That is my most enjoyable time. I come seeking you out when I want to have conversations because I know we can have conversations and we can walk away and both learn something from it. And she and I go, "it's really a good thing". So, you know that in and of itself to know that people can come to me and be open and know that we are going to walk away and it is going to be ok. That in and of itself, I think, is powerful. But, there have been a lot of things that I have changed. My family has even noticed it. I think it's just that and I've always wanted to do that with our staff, recognizing personalities. I don't know how many of us have actually ever thought about that. Just because you do this, doesn't mean that I can't work with you or get along with you. So that was huge for me. (MCL4.Spring2008Interview)

As a result of their involvement in the mathematics curriculum leadership graduate degree program, the participants were able to handle conflict and build relationships.

The mathematics curriculum leaders thought through decision making in new ways in which they recognized the importance of listening and reconsidered the role of "telling."

The mathematics curriculum leaders were expected to carry out many actions in order to support the professional growth of teachers while assisting students to achieve high standards. The leaders supported teachers by mentoring, modeling, and facilitating

professional development. As such, the dynamics of how the mathematics curriculum leaders related to teachers underwent a change. They began to be thoughtful in the decisions that they were making. MCL2 notes, “I think before I speak, I think longer and harder. I try to think about if it is just my opinion or can I base decisions and thoughts based on what has been proven true” (MCL2.Spring2011Interview). The mathematics curriculum leaders recognized their audience and their needs. MCL3 recalls,

I think back to some of the leadership classes. Those helped a lot...Just some of those things about being aware of as a leader. You know, the personality profiles, where are you coming from, why you might think that way... So, using some of those strategies about keeping people open-minded, trying to make myself not say or do things to shut people down immediately, knowing where to get resources and how to go about what might I want to do, some of the actual resources, you know, that I shared were things that I read in those courses. But, again it’s just a lot of those skills of dealing with adult learners, and I’m still learning. It’s hard. It’s really hard. (MCL3.Spring2011Interview)

She later added,

I try to find out the thinking of all my colleagues in mathematics and share that whether I agree with it or not. I always make sure of that. Ok here’s one perspective or one concern. (MCL3.Spring2011Interview)

MCL1 began to recognize other teachers’ desires by considering an answer to the question: “Are they really wanting me to make the decision or are they just wanting to talk and me be a listener and guide them and coach them through that?”

(MCL1.Spring2011Interview). The mathematics curriculum leaders became better listeners and realized the important role of sharing information. They became better thinkers about “how to work with people” and recognized “there’s so many little things that I would have never thought would make a difference has made a difference”

(MCL2.Spring2011Interview; MCL4.Spring2011Interview).

The mathematics curriculum leaders recognized the importance of using their voices.

The mathematics curriculum leaders supported teachers, schools, and their district in efforts to improve mathematics. They carried out many duties and realized that such a role required them to speak out on issues that were reflective of their views. As such, there were times that they had to speak out for the betterment of their schools. For example, the mathematics curriculum leaders lent their “voices” to curricular issues (MCL6.Spring2011Interview). MCL5 recalled,

I was part of those conversations, but not embedded. For instance, last week there was this discussion about some curricular items through the district curriculum chair, our building chair, our director of guidance, our principal, and myself and it was an email discussion, a reply-all situation, and I added my thoughts. (MCL5.Spring2011Interview)

MCL3 recalled a moment when she spoke out on an issue concerning the 8th grade curriculum, whereas in the past she would not have done much about it:

How am I going to...Do I sit there and be quiet this time? Do I use those tools? Ok, we can disagree, but let's just get everybody's thinking out on the board about this. (MCL3.Spring2011Interview)

Another participant recollected,

I have written a few board members in that regard about appreciating their support as far as curriculum, and there would be some that would probably be against that and their continued support with the curriculum that we are using now would be appreciated. (MCL4.Spring2008Interview)

The mathematics curriculum leaders did not recognize the need for this “voice” prior to the program. Perhaps, MCL3’s statement best describes this “Well, it [the mathematics curriculum leadership graduate degree program] let me know that I had important things to say and important things to be heard and that you didn’t have to be an expert” (MCL3.Spring2011Interview). MCL6 concurred with this statement adding, “I would not have done that before. I wouldn’t have even voiced. I would have kind of sat in the

background and going oh ok that sounds good to me” (MCL6.Spring2011Interview).

Moments such as these helped the mathematics curriculum leaders to realize the value in their “voice.”

Theme 8: The mathematics curriculum leaders drew on support from others in the cohort.

The mathematics curriculum leaders entered the graduate degree program with a desire to have a support system of peers. MCL3 expressed this desire, “I guess I need opportunities to meet with other developing leaders and current leaders and talk about the things that they do and then, I don’t know, I could almost see it like a mentoring situation” (MCL3.Summer2005Interview). The mathematics curriculum leaders believed the graduate degree program satisfied this desire, as MCL6 articulated:

Even our orientation meeting was very fascinating. Because there were already some commonalities of wanting to understand where kids are coming from and where they’re going. And also how do we get math on the same level of conversation and concern in our district as literacy?
(MCL6.Summer2005Interview)

They cheered each other on as MCL2 stated, “And I was able to get to watch people that I knew were good mathematics leaders, but they didn’t seem to have a lot of confidence in themselves” (MCL2.Spring2008Interview). Subsequently, the participants believed that the graduate degree program allowed them opportunities to grow as leaders through interactions with one another. This camaraderie was built upon their different experiences and common goals. MCL7 stated,

I loved having the high school [teachers there] and learned so much from that because I didn’t realize that some of those issues were going on at that level. It was really neat because the doctoral students were fantastic. I learned so much from them. (MCL7.Spring2008Interview)

Another participant stated, “I was also excited about being with a group excited about mathematics. Those three years were hard, but that part was really fun and enjoyable” (MCL1.Spring2011Interview). The cohort not only shared their expertise inside the classroom, but they also supported each other in their leadership efforts. MCL6 shared a moment when some participants assisted her:

We had already had a really strong relationship. We had been together for three years and so we supported each other beautifully. I did a measurement extravaganza here school wide where we had stations. A bunch of the math coaches came to run the stations and then helped question the kids. And so, I think having that camaraderie from the cohort helped us a lot in our role. It was very isolating to be a coach because you really couldn’t go and talk to anybody. You know, you were in that awkward position of seeing something that really wasn’t best for kids you couldn’t necessarily go to the principal because you weren’t there as an evaluator. But at the same time you are like this isn’t best for kids. So, we’d get together and just kind of vent and problem solve.
(MCL6.Spring2011Interview)

The mathematics curriculum leaders worked together in the graduate degree program for three years during which they supported each other “beautifully” (MCL6.Spring2011Interview). They had “really strong relationships” and continued to support each other via email and talks on occasion (MCL6.Spring2011Interview). The participants got what they desired. MCL5 shared this thought,

I expected it to develop some close relationships with those people in the graduate degree program. I also expected that I would continue some close relationships that I had with the faculty over there just from work through some other grant funded things as a teacher. So, I felt like I knew the people and their styles fairly well. So, I expected very much what I got, but I didn’t walk in cold. It wasn’t like I lived somewhere else in the country and I applied for a program and found what I found. I knew almost everyone before I got started.
(MCL5.Spring2011Interview)

The mathematics curriculum leaders credit the graduate degree program for the opportunity to build a community within the group to assist their leadership development. The building of trust among the cohort members was perceived as important. They felt as

if they needed to “complete this three-year program as a team so we can support each other not only now but in the future” (MCL2.WS.CommunityBuilding.062206).

The mathematics curriculum leaders’ challenges.

Theme 9: The mathematics curriculum leaders recognized new challenges that leadership efforts introduced.

As the participants transitioned into new leadership roles as mathematics coaches, mathematics department chair, heading the mathematics vertical team, and assistant principal during the graduate degree program, they faced new challenges such as a lack of support and time constraints to juggle their teaching and leadership responsibilities.

The mathematics curriculum leaders experienced lack of support.

The participants experienced disappointment with the way the administration handled the responsibility of defining their leadership positions. One mathematics curriculum leader posited,

They [the mathematics coach] were thrown into a lion’s den. The district did a very good job of setting the table for them so that they could be really unappreciated. It became very ok for me as a teacher if you are my math coach to really not respect you at all because we all know you are not necessary.
(MCL5.Spring2008Interview)

The participants voiced a concern that leadership from above could have assisted in establishing a better environment.

The mathematics curriculum leaders also wanted their time to be protected for supporting teachers and not doing other tasks that were not related to this cause. They were asked to perform extra duties such as bus monitoring and subbing. Although, this kind of thing didn’t happen often, MCL2 recalled, “I was asked to sub Friday and I just flat out said no. I couldn’t do it; I have other stuff I have to do. Find someone else! And

then I went and hid” (MCL2.Spring2008Interview). Still, the mathematics curriculum leaders needed “an administrator that’s on the same page” (MCL7.Spring2011Interview). They needed all levels of the administration to work together. MCL7 continued, “And not only your building administrator, but district coordinator and even above that that’s got to be in place and be supportive of, you know, what’s your belief is of how you need to teach math...I think that’s crucial” (MCL7.Spring2011Interview).

The mathematics curriculum leaders were expected to support teachers. However, as the participants worked to support teachers, their efforts were often met with resistance. They observed that teachers were not utilizing the allotted mathematics time. MCL2 gave an example of this:

Literacy has always been at the forefront so it is like we are the stepchild. So, unless the teachers really love mathematics themselves or were mentored by someone that rubbed off on them, you are still fighting that battle. People will say that they will have literacy centers and teach reading and writing for two or two and a half hours a day and then, even though it is mandated that you are supposed to do at least 60 minutes plus 10 for ten-minute math, it doesn’t happen. I have seen a few schedules where there isn’t even math scheduled on Friday. Then, they don’t make it up by doing bigger chunks on Monday through Thursday; it is just not there. So, that is a big roadblock. (MCL2.Spring2008Interview)

MCL3 recalled challenges she faced in her new mathematics curriculum leadership role:

Personality conflicts, dealing with individuals who are very much totally against, you know, fight against change. So, dealing with those personalities that have the least amount of impact on everybody else, trying to move forward in a more positive direction, you know, getting people to change the way they teach without making them feel as if they were doing something wrong, right now. I still haven’t figured that out. It’s tough, a lot of challenges. (MCL3.Spring2011Interview)

Nevertheless, the mathematics curriculum leaders believed that the teachers would welcome their help. The reality was that this was not always the case.

The mathematics curriculum leaders experienced time constraints.

Time constraints regarding opportunities to support mathematics and to gain knowledge posed significant challenges for the mathematics curriculum leaders. One participant stated, “I never felt like I had time to finish anything” (MCL6.Spring2011Interview). Time for some of the mathematics curriculum leaders was split between two buildings, which was not ideal for them. MCL6 posits, “I tried my schedule in various ways. I tried being in the building and my time was not evenly split because the other school was bigger. And so they got more time” (MCL6.Spring2011Interview). Consequently, the mathematics curriculum leaders had a difficult time trying to accommodate all parties involved. The participants had limited opportunities to meet with others to identify problems, brainstorm possible solutions, and support one another across the district. The mathematics curriculum leaders needed time to fulfill the duties that were expected of them.

In addition, the mathematics curriculum leaders did not have sufficient time to read professional literature to support them. MCL2 stated, “I think I have a lot of material that I just haven’t had time to read and digest” (MCL2.2008Interview). MCL5 adds, “I think being current is a concern for anyone. So, that’s the biggest thing is being current” (MCL5.2008Interview). Challenges are inevitable, and the mathematics curriculum leaders looked to the knowledge they gained from the program to guide them through these challenges.

Summary of Findings

The following statements summarize the themes that characterize how the mathematics curriculum leadership graduate degree program influenced the participants:

- The mathematics curriculum leaders developed specialized knowledge about curriculum and leadership.
- The mathematics curriculum leaders desired additional learning experiences.
- The mathematics curriculum leaders changed their views of leadership.
 - The mathematics curriculum leaders recognized the importance of broader perspectives beyond their own contexts.
 - The mathematics curriculum leaders recognized that leadership is not limited to formal positions.
 - The mathematics curriculum leaders' perception of the qualities that leadership requires changed.
- The mathematics curriculum leaders' perception of themselves as leaders changed.
 - The mathematics curriculum leaders' confidence grew.
 - The mathematics curriculum leaders viewed themselves as leaders.
- The mathematics curriculum leaders' perception of how others viewed them as leaders changed.
- The mathematics curriculum leaders assumed new leadership roles and responsibilities.
- The mathematics curriculum leaders approached situations differently.
 - The mathematics curriculum leaders interacted with people in ways that would build relationships and address conflict using different strategies.
 - The mathematics curriculum leaders thought through decision making in new ways in which they recognized the importance of listening and reconsidered the role of "telling."
 - The mathematics curriculum leaders recognized the importance of using their voices.
- The mathematics curriculum leaders drew on support from others in the graduate degree program.
- The mathematics curriculum leaders recognized new challenges that leadership efforts introduced.
 - The mathematics curriculum leaders experienced lack of support.
 - The mathematics curriculum leaders experienced time constraints.

Discussion of Findings

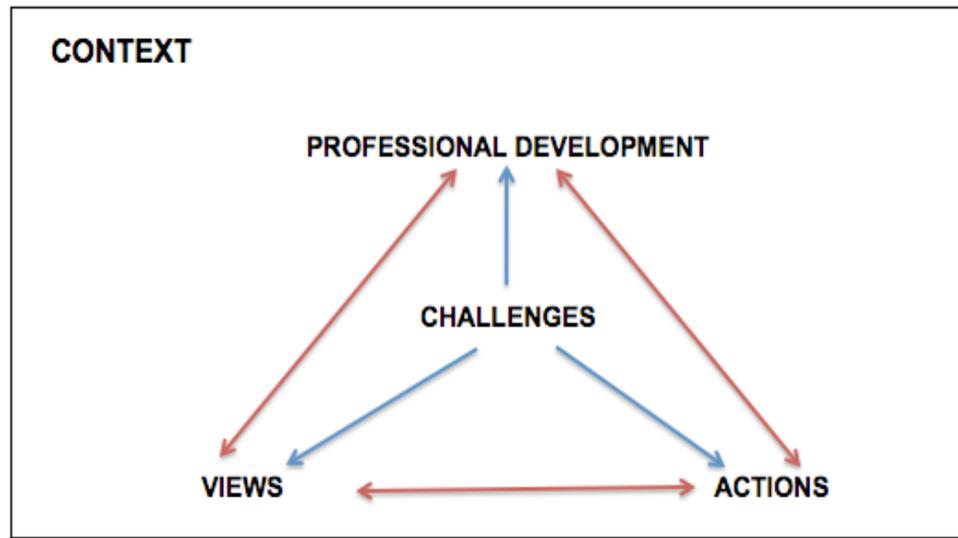


Figure 3. Critical factors that influence the work of mathematics curriculum leaders.

This study examined four critical components (i.e., professional development, views, roles/actions, and challenges as seen in *Figure 3*) that influenced the work of seven mathematics curriculum leaders enrolled in a graduate degree program. While engaged in rich discussions, role-plays, various writing assignments, the participants expanded their views of mathematics curriculum leadership, which in turned influenced their actions (e.g., see *Figures 6 and 7*).

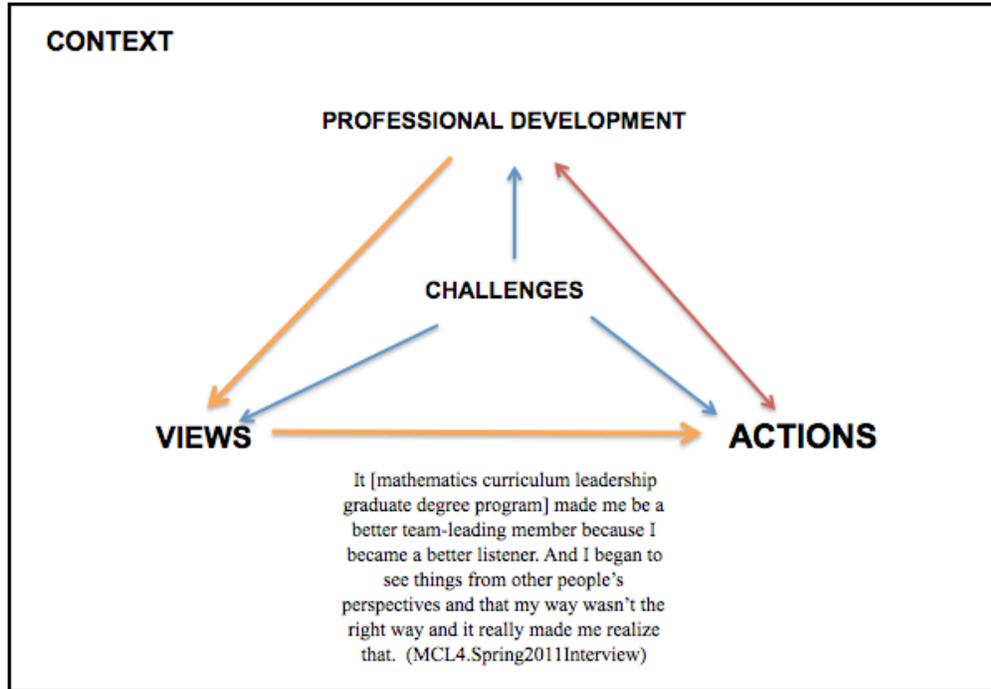


Figure 6. The influence of professional development on views, and the influence of views on actions.

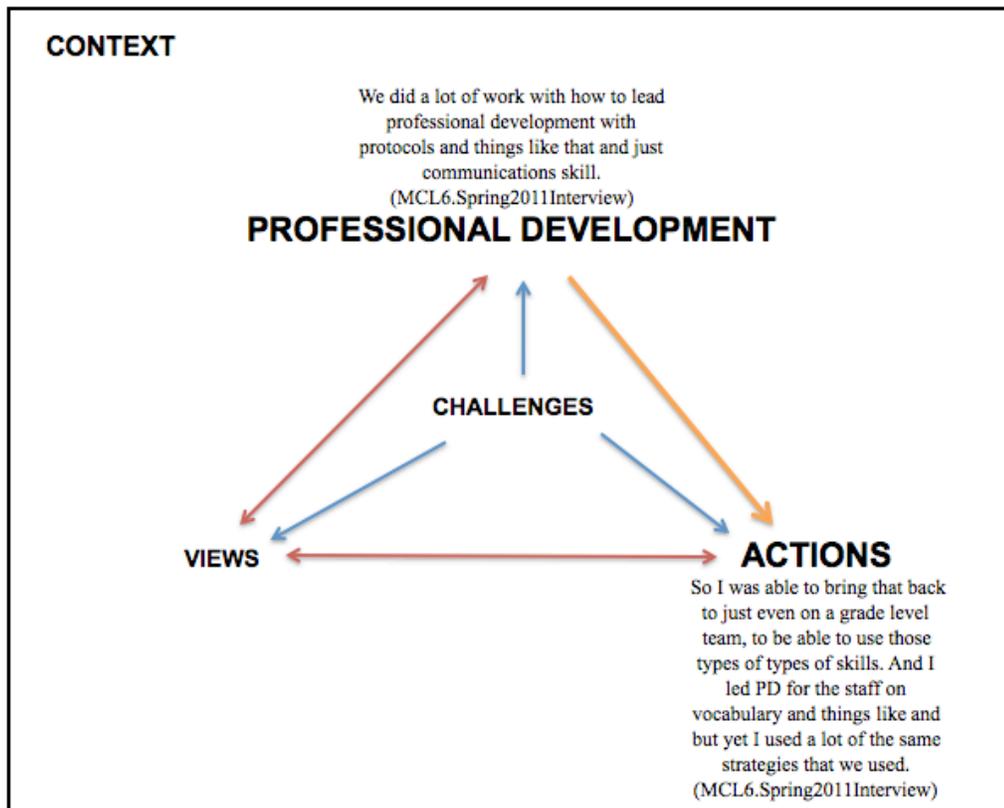


Figure 7. The influence of professional development on actions.

Participants assumed new roles, both formal (e.g., mathematics coach) and informal (e.g., sharing lesson ideas), brought about new actions, which influenced their professional development and views (see *Figure 8*). For example, when MCL2 assumed new mathematics curriculum leadership roles, she was viewed as the expert. She notes this as the following, “I think they always see you as that expert teacher” (MCL2.Spring2011Interview). This was not the perception that she wanted them to have. She insists that she learns from the teachers as well. She states, “I always learn when they [teachers] teach” (MCL2.Spring2011Interview).

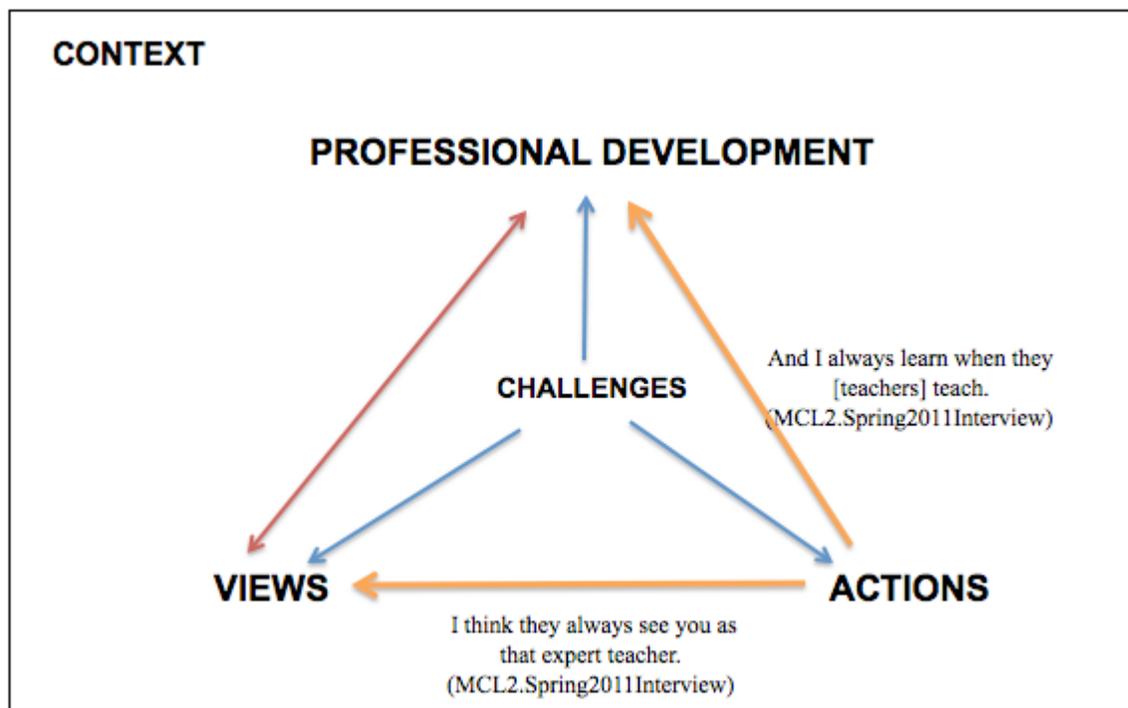


Figure 8. The influence of actions on views and professional development.

As he participants expanded their views of mathematics curriculum leadership, their views, in turn, influenced their actions and professional development (see *Figure 9*). For example, MCL2’s broader view of mathematics affected her actions. She states, “It’s not just about the 26 kids in my room, it’s about all of the 5th graders across the district and

all of the teachers and all of the needs because every school we know has different needs” (MCL2.Spring2011Interview). As a mathematics coach, she utilized this view to expand upon her actions for supporting teachers as illustrated in *Figure 9*.

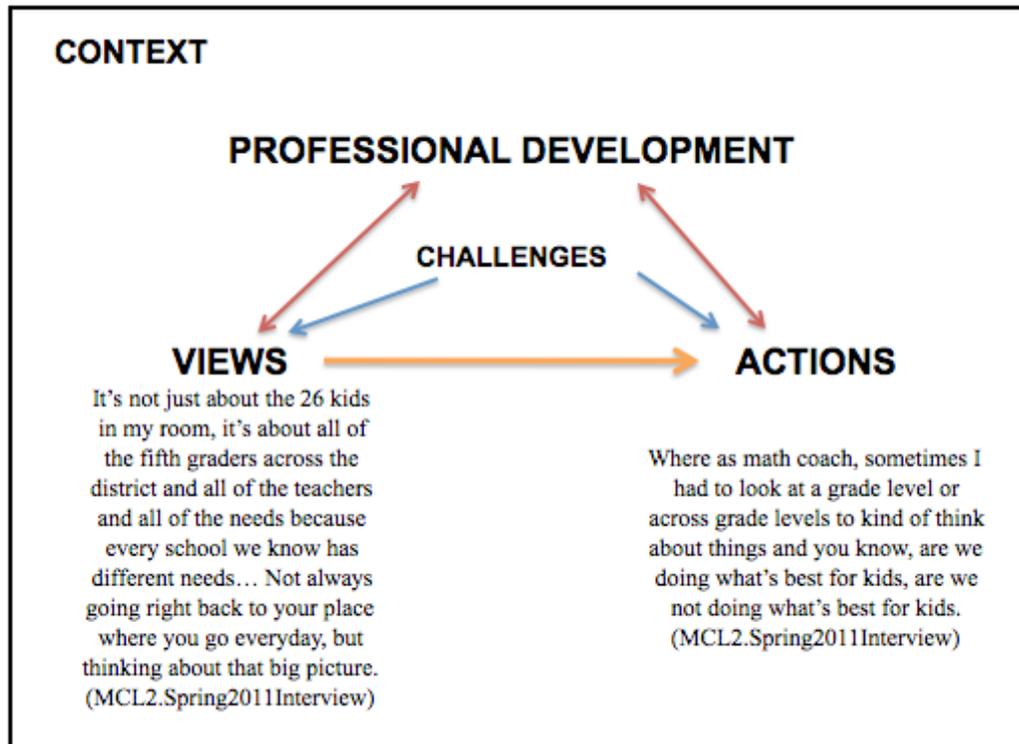


Figure 9. The influence of views on actions.

All four components (professional development, actions, views, and challenges) need to be considered in designing professional development experiences and support structures for mathematics curriculum leaders. Other studies have investigated individual components. For example, Gigante and Firestone (2007) investigated the presence of appropriate material and social resources that facilitate the actions of leaders while Chval et al. (2010) studied the challenges of teachers as they transitioned into the role of mathematics coaches. Yet, there have not been efforts to examine how leaders’

participation in a long-term professional development experience (e.g., graduate degree program) influenced these critical components.

The graduate degree program significantly influenced the leaders and supported their efforts, suggesting that a district model may be a more effective approach than graduate programs for individuals from a variety of districts. In fact, this program's design was different from other programs. Studies revealed that other programs involved participants from multiple districts (Even, 1999; Gigante & Firestone, 2007), participants from targeted schools (Nickerson & Moriarity, 2005), and a certificate of completion (Nickerson & Moriarity, 2005). The graduate degree program provided the participants with opportunities to develop specialized curricular and leadership knowledge in mathematics. This program was offered to teachers at the elementary and secondary levels within a specified school district. The graduate degree program consisted of 32 credit hours of coursework, spanned three years resulting in a master's or specialist degree. The participants acquired knowledge of the mathematics content, how mathematical ideas should develop over time, as well as how mathematics content is presented in mathematics curriculum materials across grade levels. An integral part of the graduate degree program focused on leadership, allowing the participants to gain skills and knowledge for working with adults. All the participants recognized that they developed mathematics curriculum and leadership knowledge as a result of their involvement in the mathematics curriculum leadership graduate degree program, thus supporting the claim that specialized formal training for mathematics curriculum leaders can ensure successful development of leaders (Chval et al., 2010).

The seven participants of this study assumed new formal leadership roles, such as mathematics coach, head of the mathematics vertical team, mathematics department chair, and assistant principal, as well as informal roles such as mathematics discussions with teachers in passing. Such new roles were reminiscent of roles identified by several researchers (Chval et al., 2010; Even, 1999; Gigante & Firestone, 2007; Halai, 2007; Nickerson & Moriarity, 2005). It should be noted that four of the participants in the current study also participated in the Chval et al. study. Thus, it is not surprising that both studies reported similar findings. Expectations for the mathematics curriculum leaders' actions were typically focused on supporting teachers. Their positions were intended to increase students' academic achievement by assisting teachers to improve their instructional strategies (Chval et al., 2010; Mangin, 2010; York-Barr & Duke, 2004). The leaders who assumed the roles of mathematics coach and assistant principal were no longer full-time teachers. These particular leadership roles led to a significant reduction or elimination of working directly with students; thereby, allowing the mathematics curriculum leaders to support teachers the majority of their time. The other roles, the head of the mathematics vertical team and mathematics department chair, were suggestive of Katzenmeyer and Moller's (2001) conceptualization of teacher leadership, which states that teacher leaders can fulfill their leadership duties while they remain in the classroom.

As new leadership roles were assumed, the mathematics curriculum leaders initiated new actions in their professional lives. The mathematics curriculum leaders had a focus at the classroom level where they supported teachers by modeling mathematics lessons, mentoring, coaching, and facilitating mathematics discussions, which are similar to actions described in several studies (Campbell & Malkus, 2011; Gigante & Firestone,

2007; Halai, 1998; York-Barr & Duke, 2004). However, in order to be effective with their colleagues, the mathematics curriculum leaders needed to learn a variety of leadership skills, including how to build trust and develop rapport (i.e., team building), create communication networks, and deal with time and conflict management, as claimed by Chval et al. (2010). As a result of the participants' involvement in the mathematics curriculum leadership graduate degree program, they approached situations differently.

Participants' views of mathematics curriculum leadership underwent a change as a result of their involvement in the three-year mathematics curriculum leadership graduate degree program. The participants entered the program with predetermined views of curriculum leadership, which included ideas of accepting and valuing different learning styles, advocating for kids, being a learner, being a positive role model, being a practitioner, being knowledgeable, and willing to share with others (MCL1.Summer2005Interview). Researchers claim that teacher and curriculum leaders experience conflicting views of the roles they are to assume, which are contradictory to the reality of their roles (Chval et al., 2010; Even, 1999; Halai, 1998). As such, the participants' views of curriculum leadership expanded. They viewed curriculum leaders as individuals who should (MCL1.Spring2008Interview; MCL1.Spring2011Interview):

- Be accepting
- Be flexible
- Be hard working
- Be in teachers' classrooms
- Be a good listener
- Be motivated
- Coach teachers
- Value teachers
- Endorse students working in learning communities
- Have really good people skills
- Maintain a repertoire with teachers
- Be aware of all the factors that play a part of curriculum

- Endorse students to know *mathematics* conceptually
- Be knowledgeable about *mathematics* curricula, instruction, and assessment in general for all grade levels
- Read professional literature on *mathematics* curriculum and instruction and reflect
- Attend and facilitate professional development opportunities related to *mathematics* education on local, state, and national levels
- Bring teachers forward in their thinking and ideas of *mathematics*
- Be a catalyst for teachers to think about *mathematics* in a different way
- Be a negotiator for *mathematics*
- Be aware of district, state, and national *mathematics* expectations
- Be passionate about *mathematics* and the importance of *mathematics*
- Constantly learn about *mathematics*
- Know what good *mathematics* teaching and instruction is
- Realize how important it is for kids to get a really good foundation in *mathematics*

The mathematics curriculum leaders views of leadership influenced their work (Chval et al., 2010). Similar to the findings reported by Even (1999), with time and the opportunity to be a part of the graduate degree program, the mathematics curriculum leaders' views changed.

The mathematics curriculum leaders faced several challenges concerning support and time, similar to those reported by other researchers (Chval et al., 2010; Even, 1999; Gigante & Firestone, 2007; Halai, 2007; Nickerson & Moriarity, 2005). The leaders welcomed the support of the staff, but at times they felt that teachers and administrators did not support them as they transitioned into their new mathematics curriculum leadership roles. As York-Barr and Duke (2004) claimed in their study, intentional and systematic efforts to support leadership appeared to be severely lacking by teachers and administrators. The design of the mathematics curriculum leadership graduate degree program appeared to help in this regard. With the district-based model, there was a priority to design the program based on the leadership needs of the specific district. Moreover, the participants were able to create a support network within their new

leadership roles and responsibilities. Working in the new mathematics curriculum leadership positions left the leaders needing support from administrators and teachers.

The participants in this study experienced the challenge of time constraints much like the teacher and curriculum leaders in the Chval et al. (2010) and Devaney (2000) studies. The mathematics curriculum leaders experienced time constraints in addressing reading professional literature along with collaborating with other leaders to discuss issues surrounding mathematics. During the graduate degree program, the participants were able to address this issue. However, the members of this study are still experiencing the same time constraints.

Many forces (e.g., views, roles, actions, challenges) both within and beyond their control often influenced the responses of the mathematics curriculum leaders. As the mathematics curriculum leaders worked within their new organizational structures, they fulfilled many needs. The mathematics curriculum leaders felt empowered and strengthened by the support received from the graduate degree program as they transitioned into their new roles. This study extends our knowledge of mathematics curriculum leadership development as well as deepening our understanding of four critical components (views, actions, roles, and challenges) that influence mathematics curriculum leaders.

Chapter 5: Implications, Limitations, and Significance

An intrinsic multi-descriptive case study method was employed to ascertain how a specialized long-term professional development experience (i.e., graduate degree program) in mathematics curriculum leadership influenced seven participants' views about leadership, the roles and actions they performed along with how they responded to the new challenges they faced. Written responses, journals, questionnaires, and interviews were used to create detailed descriptions of the participants. As demonstrated in Chapter 4, the graduate degree program influenced the participants. For example, the mathematics curriculum leaders developed specialized knowledge about curriculum and leadership in mathematics. They changed their views about leadership. The mathematics curriculum leaders assumed new leadership roles in which they approached situations differently. As a result, the leaders recognized that administrators and colleagues perceived them in new ways. In this chapter, I discuss the implications, limitations, recommendations for future research, and significance of the study.

Implications

The mathematics curriculum leadership graduate degree program was a unique program that involved a specific school district to develop teachers' knowledge of mathematics curriculum and leadership. The participants in this study were involved in a program that focused on developing mathematics curriculum leadership and supporting their leadership efforts in their school district. They were also encouraged to expand their leadership efforts beyond the local level and become involved with national organizations and communicate professionally with regional and national audiences. Participants drew on support from each other that continued to exist three years after the completion of the

program. As such, this study has implications for the design of future professional development opportunities for mathematics curriculum leaders, school district administrators who support these leaders' efforts, potential and/or practicing mathematics curriculum leaders, as well as future research as described in the following paragraphs.

Implications for the design of professional development.

The themes that resulted from this research highlight how one graduate program influenced mathematics curriculum leaders. Thus, the results have the potential to influence the design of future professional development or graduate programs related to mathematics curriculum leadership. Of course, the design of any professional development experience should consider characteristics of effective professional development identified in the research literature (e.g., see Garet et al., 2001). In addition, the results from this study also provide insights into designing an experience specific for mathematics curriculum leaders. First, the results suggest that mathematics curriculum leaders should participate in long-term experiences that prepare them to do the complex work of leadership in their schools.

Second, mathematics curriculum leaders need to develop specialized knowledge about mathematics curriculum and leadership that they did not attain from their classroom teaching experiences. Recently, four professional organizations (i.e., Association for Mathematics Teacher Educators (AMTE), Association of State Supervisors of Mathematics (ASSM), NCTM, and NCSM) released a position statement about the role of elementary mathematics specialists. They identified five needs for these professionals including (1) deep and broad understanding of mathematical content, including the specialized knowledge needed for teaching; (2) solid knowledge of the

elementary context; (3) expertise in using and helping others use effective instructional and assessment practices informed by knowledge of mathematical learning trajectories; (4) knowledge and skills for working with adult learners; and (5) leadership skills necessary to influence and support educational efforts to improve the teaching and learning of mathematics. Although they identified general areas that elementary mathematics specialists need to develop, the field needs to further articulate the nature of the specialized knowledge that mathematics curriculum leaders need to develop at all levels with consideration of the different types of roles these professionals perform (i.e., not limited to elementary mathematics specialists). In other words, what should mathematics curriculum leaders know and be able to do? How can we best help mathematics curriculum leaders develop the knowledge and competencies to do this work?

Third, five of the seven participants in this study completed graduate degrees prior to entering the mathematics curriculum leadership graduate degree program. Yet, it was striking that these previous programs did not prepare them for their mathematics curriculum leadership efforts. This provides more evidence that the core issue is not just completing a graduate program, but what is the content of that program? Mathematics curriculum leaders need graduate programs that specifically target mathematics curriculum and leadership.

Fourth, mathematics curriculum leaders need support while they participate in professional development experiences and while they engage in leadership activities. In other words, their professional development experiences should not be done in isolation

from their leadership work in schools. They also need a network (e.g., other members in the program cohort) to support their new leadership efforts.

Fifth, designers of professional development experiences for mathematics curriculum leaders should consider more than knowledge and competencies (i.e., views, actions/roles, challenges and context). The design should also consider how to encourage participants to interact with leaders at local, state, and national levels.

Finally, professional development models created for specific districts may be more sustainable than programs for individuals not linked by common goals or a common work site.

Implications for school district administrators.

Participation in the mathematics curriculum leadership graduate degree program yielded successful leadership efforts in local schools. For example, MCL6 described a successful experience she had with her colleague:

I guess one in particular, I consider her my success story. She was very much opposed to Investigations. She was very much just drill and I mean, that's what math is and that's good enough for me, and so by going in and teaching lessons in her classroom with the kids and her listening to the questions that I was asking. She had a lot of ah-ha's her self going, "I never understood how that worked". So she really became a convert and I was so excited. And you know, she'll still seeks me out sometimes and go "guess what we did today". So, that was really fun. (MCL6.Spring2011Interview)

The participants believed that the program guided them to become better mathematics curriculum leaders, helped them develop knowledge that they needed to do the work, and built their confidence. As a result, the leaders shared this knowledge and expertise with teachers throughout their schools, district, and on the national level. They reported that their initiative facilitated a change in the mathematics conversations that took place in their schools. Yet, they also recognized that they needed the support of district

administrators to make their efforts successful. Therefore, as school districts work to design future experiences to prepare mathematics curriculum leaders, they must also be purposeful about how district administrators can best support the leaders' efforts.

School administrators play a critical role in supporting novice mathematics curriculum leaders. Some challenges faced by beginning leaders could be diminished or prevented with additional administrative planning or resources. Particular attention should be given to facilitate interactions among new leaders in districts. Administrators should allocate time for leaders to continue their professional growth as well as planning their leadership initiatives. They also need to carefully consider how they design, initiate, and implement support structures (e.g., workload assignments) for new leaders. Even though some challenges may be diminished or even prevented, others are inevitable. That is, some challenges will be faced by every novice leader. Therefore, new leaders need strategies they can initiate to address the challenges and stress that they will undoubtedly face. School administrators can support novice leaders by helping them develop strategies for initiating and participating in both formal (programs) and informal support structures. Furthermore, district administrators should celebrate and honor their leaders. For example, when the four participants in this study published their first manuscript, they were thrilled when their principals and superintendents acknowledged their success.

Due to budget issues, many of the mathematics curriculum leadership positions (i.e., the mathematics coaches, the head of the vertical mathematics team) were eliminated at the height of the participants' enthusiasm, which left some dejected. The mathematics curriculum leaders were dismayed by the district's decision to discontinue their roles. However, in order to keep the role of mathematics curriculum leader viable, funding for

such roles will have to be sustained. “Schools and districts should not invest in teacher leaders unless they intend to support teacher leaders adequately through time, administrative follow through, and training to help teachers develop the positive social relations on which their work depends” (Gigante & Firestone, 2008, p. 302).

Implications for potential or existing leaders.

The mathematics curriculum leaders in this study developed specialized knowledge related to mathematics curriculum and leadership. They also changed their views about leadership and assumed new leadership roles while they participated in a specialized graduate degree program. Program faculty helped them build confidence about their leadership efforts. The results from this study suggest that potential and existing leaders should seek opportunities to develop specialized knowledge that focuses on both mathematics curriculum and leadership that they will not learn through their teaching experiences. The mathematics curriculum leaders should also pursue opportunities to discuss mathematics and leadership and develop support networks with other leaders. The following quote from MCL6 illustrates the importance of this idea,

We already had a really strong relationship. We had been together for three years and so we supported each other beautifully. I did a measurement extravaganza here school wide where we had stations. A bunch of the math coaches came to run the stations and then helped question the kids. And so, I think having that camaraderie from the cohort helped us a lot in our role.
(MCL6.Spring2011Interview)

In addition, potential and current curriculum leaders should seek time for their own professional growth. Many of the participants in this study wanted to continue to keep up with current issues and trends in mathematics education, but encountered difficulty managing all the demands on their time. Therefore, potential and current curriculum

leaders should recognize that they will need to prioritize finding ways to build space into their calendars to continue to develop professionally.

Implications for future research.

This *intrinsic multi-descriptive* case study investigation lends understanding of four critical components (i.e., views, professional development, roles/actions, and challenges) that influenced mathematics curriculum leaders as they assumed new mathematics curriculum leadership roles. Although the data gleaned from this study suggest numerous changes in the mathematics curriculum leaders' views, roles, actions, and challenges, the research process revealed themes that need further investigation; therefore, areas remain that are not fully understood. Future research will not only enhance this study but also contribute to the growing body of literature on mathematics curriculum leadership. Additionally, work should investigate how other staff members play into mathematics curriculum leadership, looking at larger school districts, examining a larger sample size, comparing different models of graduate programs, and further examining the conceptual framework.

The data sources analyzed in this study were limited to those provided by the teachers from the mathematics curriculum leadership graduate degree program. Mathematics curriculum leaders insist they need the cooperation of key members of the school (e.g., teachers, administrators) in order to be successful. These key individuals did not contribute a voice in understanding the teachers' transition to subsequent leadership roles. The exclusion of these individuals should not be interpreted as a rejection of their importance; rather, a comprehensive examination of the array of individuals associated with the participants would be a fruitful area for future investigation. As such, this study

does not directly offer an exhaustive portrayal of the roles, which principals and other teachers play in the teachers' transition to leadership. Therefore, future research should investigate the influence of mathematics curriculum leaders on teachers' practice and school improvement.

The size of the school district may be another factor to consider. The district where the mathematics curriculum leaders work is relatively small compared to some urban districts. Further research within a larger school district may suggest new insights as to how mathematics curriculum leaders transition into new roles upon the completion of a formal specialized program such as the one noted in this study. As such, a future study could compare different school districts' contexts. This study could utilize the four components that influence mathematics curriculum leadership, thus noting how the different districts influence the four components of the model and the relationships amongst the components.

The conceptual framework was originally designed with challenges influencing the other three component, professional development, actions, and views (as seen in *Figure 3*). However, upon further exploration, it was evident that the three components also influenced challenges. For example, MCL6's challenge with time affected her ability to pursue further professional development opportunities. "Yeah. I mean, because there's fabulous literature out there. [Need] time to read it, and study it, try it out. You know, I would love to keep taking class and stuff and learning" (MCL6.Spring2011 Interview). Thus, the conceptual framework was modified to accept this accommodation (as seen in *Figure 10*). However, future research efforts should look to further verify the conceptual framework.

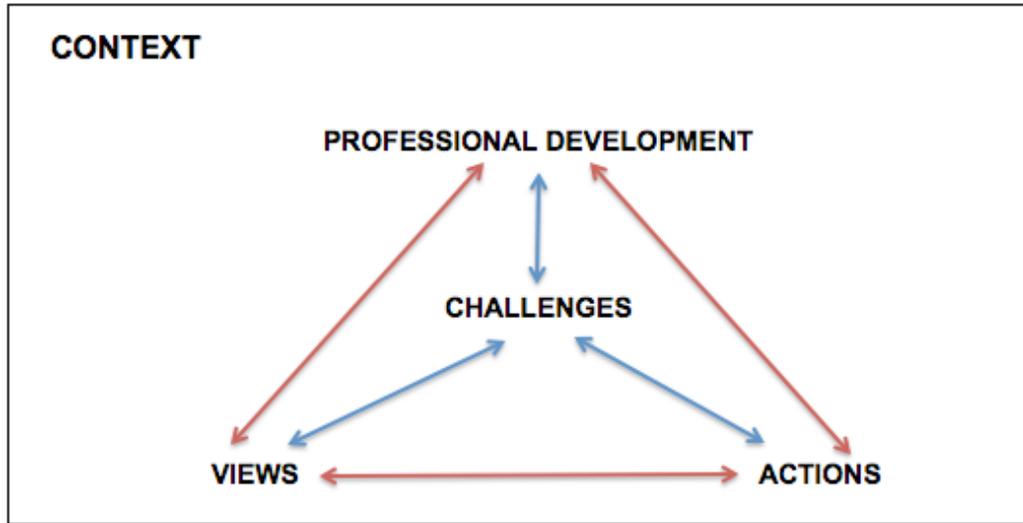


Figure 10. Critical factors that influence the work of mathematics curriculum leaders (Revised).

Limitations

Although the study had a strong research design, I acknowledge three limitations. First I analyzed existing data that was collected from 2005-2008 based on another study. As such, that initial data was not based on the current research question and framework. Thus, some interview responses, writing responses and journal entries were not utilized since it captured participants' general responses for leadership (e.g., being a leader with an auto club). Still, some interview questions focused on curriculum leadership in which rich information about mathematics curriculum leaders was extracted. In addition, the interviews conducted in 2011 were designed based on the current study.

Second, I utilized self-reported data from the participants (i.e., writing responses, questionnaires, interviews, journals) for this study. I did not observe their actions in their settings or observe them as they participated in the graduate degree program. Moreover, I did not interview their colleagues or administrators to determine the influence they had in

their contexts. However, the data sources did capture the participants' perceptions about their views and experiences.

Focusing on a rich data set for seven mathematics curriculum leaders provided an opportunity to depict "rich, in-depth" perspectives of the leaders (Creswell, 2003, 2008; Patton, 1990; Yin, 2003). Although these results provide new insights about mathematics curriculum leaders, I caution the readers about the extent to which they generalize these findings without further research (Yin, 2003). The findings from this study are specific to mathematics curriculum leaders who participated in a unique graduate degree program in a unique context. Other graduate programs or professional development experiences may facilitate different views and leadership actions, which is further discussed in the section below.

Significance

Mathematics curriculum leadership can be a resource to assist in NCTM's *Principles and Standards for School Mathematics* (2000) vision of all students having access to rigorous, high-quality mathematics instruction. Mathematics curriculum leaders can facilitate school improvement efforts and support teachers as they work to improve their teaching so that ultimately, students are more successful learning mathematics. Yet, we need more mathematics curriculum leaders to do this important work and we need more professional development opportunities to prepare and support these leaders. Moreover, schools must establish effective structures that support mathematics curriculum leaders' efforts. Unfortunately, districts and schools do not always possess the appropriate infrastructure to prepare and support the acquisition of the specialized knowledge that mathematics curriculum leaders need. Consequently, mathematics curriculum leaders

pursue professional development opportunities through professional literature, conferences, or university degree programs. Regrettably, these efforts have been helpful for isolated individuals within districts, but in most cases have not developed a community of teacher leaders (Katzenmeyer & Moller, 2001).

The graduate degree program investigated in this study was unique in that it prepared a group of curriculum leaders from one school district and it involved participants who taught mathematics from kindergarten to advanced placement (AP) calculus. The results from this study document specialized knowledge that the participants developed, how their views about leadership changed, and the roles and actions they assumed. More important, it illustrates how these components influenced one another. Ultimately, the results from this study can inform the design of future professional development and graduate programs focused on mathematics curriculum leadership. The findings generated from this study will also help mathematics teacher educators as well as school and district administrators to support teachers as they transition into curriculum leadership roles and continue to grow professionally.

The participants believed that the mathematics curriculum leadership graduate degree program was a success and one that should be replicated. Perhaps, MCL7 states this the best, “I loved it. I would love to see it followed up. I think that would be awesome. I really think that they should have that [graduate degree program] again” (MCL7.Spring2011Interview).

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APPENDIX A: 2005 QUESTIONNAIRE

1. How strongly do you agree/disagree with the following statements? (Check one box on each line.)

Statements	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
a. I feel supported by colleagues to try out new ideas in my mathematics teaching.					
b. I have time during the regular school week to work with my peers on mathematics curriculum.					
c. I have time during the regular school week to work with my peers on mathematics instruction.					
d. I am well-informed about National Standards for the grades I teach.					
e. I am well-informed about the Missouri Framework for the grades I teach.					
f. I am well-informed about the Missouri Grade Level Expectations for the grades I teach.					
g. I am well-informed about the Missouri Grade Level Expectations for grades other than the ones I teach.					

2. In the past **12 months**, have you participated in the following activities? (Check one box on each line.)

Professional Activity	YES	NO
a. Facilitated professional development in mathematics subject matter		
b. Facilitated professional development in mathematics teaching		
c. Mentored another teacher as part of a formal arrangement that is recognized or supported by the school or district, not including supervision of student teachers		
d. Supervised student teachers		

e. Received local, state, or national grants or awards for mathematics teaching		
f. Served on a school or district mathematics curriculum committee		
g. Served on a school or district mathematics textbook selection committee		

3. In the past **3 years**, have you participated in the following professional development activities? (Check one box on each line.)

Professional Development Activity	YES	NO
a. Completed a college/university mathematics course (Do not include undergraduate degree requirements)		
b. Completed a college/university course in the teaching of mathematics (Do not include undergraduate degree requirements)		
c. Observed other teachers teaching mathematics as part of your own professional development (formal or informal)		
d. Met with a local group of teachers on a regular basis to study/discuss mathematics teaching issues		
e. Met with a local group of teachers on a regular basis to study/discuss mathematics curriculum issues		
f. Collaborated on mathematics teaching issues with a group of teachers at a distance using telecommunications		
g. Served as a mentor and/or peer coach in mathematics teaching, as part of a formal arrangement that is recognized or supported by the school or district (Do not include supervision of student teachers)		
h. Attended a workshop on mathematics teaching specify: _____		
i. Attended a professional mathematics teaching conference specify: _____		
j. Read professional literature related to mathematics education. specify: _____		
k. Other, specify: _____		

4. How many hours have you spent on professional development in **mathematics teaching** during each of the following time periods? (Include attendance at professional meetings, workshops, and conferences, job-embedded professional development, but do not include formal courses for which you received college credit or time you spent providing professional development for other teachers.) (Make one check in each column.)

Hours of Professional Development	Last 12 Months	Last 3 Years
None		
Less than 6 hours		
6-15 hours		
16-35 hours		
More than 35 hours		

5. How many hours have you spent on professional development in **mathematics subject matter** during each of the following time periods? (Include attendance at professional meetings, workshops, and conferences, job-embedded professional development, but do not include formal courses for which you received college credit or time you spent providing professional development for other teachers.) (Make one check in each column.)

Hours of Professional Development	Last 12 Months	Last 3 Years
None		
Less than 6 hours		
6-15 hours		
16-35 hours		
More than 35 hours		

6. How many hours have you spent on professional development related to **mathematics curriculum** during each of the following time periods? (Include attendance at professional meetings, workshops, and conferences, job-embedded professional development, but do not include formal courses for which you received

college credit or time you spent providing professional development for other teachers.) (Make one check in each column.)

Hours of Professional Development	Last 12 Months	Last 3 Years
None		
Less than 6 hours		
6-15 hours		
16-35 hours		
More than 35 hours		

7. How many hours have you spent on professional development in **leadership development** during each of the following time periods? (Include attendance at professional meetings, workshops, and conferences, job-embedded professional development, but do not include formal courses for which you received college credit or time you spent providing professional development for other teachers.) (Make one check in each column.)

Hours of PD	Last 12 Months	Last 3 Years
None		
Less than 6 hours		
6-15 hours		
16-35 hours		
More than 35 hours		

8. What professional development topics would help you become a better mathematics **curriculum leader**? (For each chart, check all that apply.)

Check all that apply:	Mathematics
	a. Numeration and number theory
	b. Computation
	c. Computational estimation
	d. Measurement
	e. Pre-algebra
	f. Algebra

	g. Patterns and relationships
	h. Geometry and spatial sense
	i. Functions (including trigonometric functions) and pre-calculus concepts
	j. Data collection and analysis
	k. Probability
	l. Statistics
	m. Topics from discrete mathematics
	n. Mathematical structures
	o. Calculus
	p. Technology (calculators, computers) in support of mathematics
	q. Other, specify: _____

Check all that apply:	Teaching and Learning
	a. Inquiry or problem-based strategies in mathematics
	b. Inquiry or problem-based mathematics curriculum
	c. Classroom management in mathematics
	d. Developing conceptual understanding in mathematics
	e. How students learn particular topics in mathematics
	f. Designing instruction for special education students in mathematics
	g. Designing instruction for gifted students in mathematics
	h. Designing instruction for ESL students in mathematics
	i. Connecting mathematics to the real world
	j. Involving girls and minorities in mathematics
	k. Involving parents in their children's mathematics education
	l. Using technology to teach mathematics
	m. Using models and manipulatives to teach mathematics
	n. Assessing student learning in mathematics
	o. Using the Missouri Frameworks and Grade Level Expectations to design instruction in mathematics
	p. Questioning and classroom discussion techniques for mathematics
	q. Cooperative/collaborative learning in mathematics
	r. Writing in mathematics
	s. Developing critical thinking in mathematics
	t. Developing problem solving in mathematics
	u. Other, specify: _____

Check all	Leadership
------------------	-------------------

that apply:	
	a. Developing Supportive Organizational Arrangements
	b. Providing Professional Development
	c. Developing Positive Attitudes
	d. Classroom Observation Techniques
	e. Providing Feedback on Curriculum Use
	f. Promoting Effective Curriculum Use in Small Groups
	g. Identifying Obstacles to School-wide Improvement
	h. Designing Strategies for Addressing Obstacles to School-wide Improvement
	i. Communicating with Critical Audiences-School Administrators
	j. Communicating with Critical Audiences-School Faculty
	k. Communicating with Critical Audiences-Parents
	l. Monitoring Curriculum Improvement Efforts
	m. Assessing Curriculum Improvement Efforts
	n. Understanding and Analyzing Standardized Test Results
	o. Evaluating Curriculum Materials
	p. Grant Writing
	q. Supporting Teachers in a Study Group
	r. Presenting at Mathematics Education Conferences
	s. Mathematics Curriculum-Related Research
	t. Understanding the Role and Impact of Curriculum Materials on Student Learning and Teacher Practice
	u. Strategies for Helping Administrators Understand the Role and Impact of Innovative Mathematics Curriculum
	v. Other, specify: _____

9. What are 3 characteristics of effective professional development?

10. What are 3 characteristics of ineffective professional development?

11. Rank **three** statements from the list below that are the primary obstacles for your participation in mathematics professional development. **Please rank only three, with 1 being the greatest obstacle.**

- ___ Lack of financial support from school/district
- ___ Low value placed on professional development by school/district
- ___ School/district reluctance to release me from classroom responsibilities
- ___ Location of professional development not convenient
- ___ Unavailability of substitutes
- ___ Unawareness of available professional development
- ___ Lack of interest in professional development topics available
- ___ Lack of time to devote to professional development
- ___ Lack of relevance to job
- ___ Cost
- ___ Family responsibilities
- ___ Other (please specify) _____

12. What skills and knowledge would help you be a more effective curriculum leader in your school and district?

13. If you could design your ideal professional development experience, what would it look like?

What topic? _____

What kinds of activities for participants? _____

When? How long? How often? _____

Where?

Who would lead the professional development? _____

Who would participate? _____

What would be the benefits of participating? _____

Anything else?

Other Information

a. Name

b. What grade levels/courses did you teach during the 2004-2005 school year? Be specific.

c. What grade levels/courses do you intend to teach during 2005-2006? Be specific.

d. Undergraduate degree:

Undergraduate Institution:

Major:

Mathematics

Education

Other (specify):

e. Graduate degree:

Institution:

Degree/Major:

f. Are you certified to teach the grade(s)/subject(s) you are teaching?

Yes No

Certification(s)/endorsement(s) held:

-
- g. To which mathematics professional organizations do you belong? (Check all that apply.)
- NCTM: National Council of Teachers of Mathematics
 - MCTM: Missouri Council of Teachers of Mathematics
 - NCSM: National Council of Supervisors of Mathematics
 - Other, specify:
-

- h. How do these professional organizations support your career?
-

- i. Have you read an article from a professional journal in the last month? If so, from which journal? What was the topic of the article?
-

APPENDIX B: SUMMER 2005 AND SPRING 2008 INTERVIEW PROTOCOL

1. What do you like about teaching mathematics?
2. How has your mathematics teaching changed during the course of your career?
3. How do you typically spend your time during a workweek (i.e., what percent on instruction? Leadership? Other?)?
4. Are you familiar with the NCTM Principles and Standards? What are your impressions of the Principles and Standards?
5. How would you describe mathematics instruction in your school?
6. How have you been involved with the curriculum reform efforts in your school or district?
7. In what ways does the district-adopted textbook influence **what** you teach as well as **how** you teach mathematics?
8. If you could design the ideal mathematics curriculum, what would it contain and how would it be organized?
9. Were you involved in choosing INVESTIGATIONS (CMP, CORE-PLUS)?
 - a. If YES--Describe that review process?
 - b. If NO--Would you have advocated the selection of this curriculum? Tell why.
10. What qualities do you think a curriculum/instructional leader should possess?
11. Who would you identify as a curriculum/instructional leader in your school? What qualities does that person have?
12. What are the current leadership **roles** you play in your school? District? Other forums?
13. What are curriculum/instructional leadership **tasks** you perform?
14. What curriculum/instructional leadership roles do you **desire**?
15. Tell me about your experiences learning mathematics either in elementary school, high school, or college. What could you use from these experiences to help you in your leadership role?
16. What type of professional development opportunities is offered for teachers at your school? How often do teachers participate in professional development?
17. What are your professional development needs regarding curriculum/instructional leadership? Mathematics? Curriculum? Teaching? Assessment? Students?
18. What are resources/structures needed to support your leadership efforts?
19. Can you explain a frustrating situation you faced this past year? How did you work through this situation? Who did you talk to about the situation? Did you use any other resources? Was the situation resolved?
20. What are the barriers to improvement in your school and district?
21. How are decisions made in your school? Who makes them?

SUMMER 2005 AND SPRING 2008 INTERVIEW PROTOCOL
(Continued with Scenario)

1. A group of parents approach the principal about removing the mathematics curriculum and calculators from the building and bringing back a curriculum that focuses on the basics. How would you respond to your principal or help your principal with this situation?
2. Imagine you are trying to lead a study group for the teachers in your school; however, one teacher is resistant and always takes the sessions off task. How would you deal with this situation?
3. You're having lunch with a colleague, a teacher, and this colleague tells you: "I have been so excited about getting my students to work better in groups. Our classroom culture now emphasizes listening, reporting each other's views and sharing ideas. But my students go to another teacher for Language Arts. This teacher calls them names and is so disrespectful. She has even threatened to hit the children! Each day when they come back to me, I have to start all over." How would you respond to this colleague?
4. You analyze the student achievement data from your school and recognize that there is a large group of students who do not perform sufficiently on probability concepts. What are potential steps you could take?
5. Imagine that you have a class of 25 students for mathematics. One student is very curious to you. The student seems capable but is slow to respond to the questions you ask the class. In fact, the student seldom volunteers to offer a response. The student is also very quiet and often stares out the window. The student also frequently makes arithmetic errors. What do you make of this student? What more information would you want about this student and how might you get the information?
6. How would you approach your principal if you wanted to initiate an improvement in mathematics teaching and learning in your school?

APPENDIX C: SPRING 2011 INTERVIEW PROTOCOL

I am interested in your perspectives on the mathematics curriculum leadership role(s) you assumed during the past two years as well as how your participation in the mathematics curriculum leadership graduate degree program influenced this leadership. Your responses will be kept confidential and only reported using a pseudonym. Do I have your permission to record the interview?

Begin with questions that will build rapport between interviewer and participant:

1. Tell me about your professional experiences. **CONTEXT**
 - a. How long have you taught? **CONTEXT**
 - b. What grade levels have you taught? **CONTEXT**
 - c. How have you been involved with the math curriculum improvement efforts in your school or district? **CONTEXT**
2. What do you enjoy most about serving as a math curriculum leader in your district? **CONTEXT/VIEWS**
3. What is a mathematics curriculum leader? **CONTEXT**
4. When you entered the MU graduate program, what was your vision or expectation of what a math curriculum leader is? Does? **VIEWS**
5. How are mathematics curriculum leadership roles and responsibilities identified and assigned in your school? **VIEWS/ACTIONS/ CONTEXT**
6. How long have you worked with your current principal?
 - a. What kinds of interactions do you have with principals?
VIEWS/ACTIONS
 - b. How do your principal view teacher leadership in general, and mathematics curriculum leadership specifically? **VIEWS**
 - c. Please describe a situation where you influenced your principal's thinking.
VIEWS/ACTIONS
 - d. Is that the kind of impact that you think was intended?
VIEWS/ACTIONS
7. What kind of interactions (formal/informal) do you have with teachers as a mathematics curriculum leader? **VIEWS/ACTIONS**
 - a. Please describe a situation where you influenced a teacher's thinking or teaching. **VIEWS/ACTIONS**
 - b. Is that the kind of impact that you think was intended?
VIEWS/ACTIONS

Based on the mathematics curriculum leadership roles identified in the email response:

8. In your email, you responded that you have assumed a mathematics curriculum leadership role related to _____.
 - a. What are some of the actions you have done in this role? **ACTIONS**
 - b. How did your participation in the MU graduate program influence your responses to these actions? **PROFESSIONAL DEVELOPMENT/ ACTIONS**
 - c. What leadership tasks do you perform? **TASKS**

- d. How did your participation in the MU graduate program influence your responses to these tasks? **PROFESSIONAL DEVELOPMENT/ TASKS**
 - e. What are some of the challenges you have faced in this mathematics curriculum leadership role? **CHALLENGES**
 - f. How did your participation in the MU graduate program influence your responses to these challenges? **PROFESSIONAL DEVELOPMENT/ CHALLENGES**
9. What do you perceive as some of the successes associated with your role as a math curriculum leader? **PROFESSIONAL DEVELOPMENT/ VIEWS/ACTIONS**
 10. What have been some situations where you did not experience success as a mathematics curriculum leader? **CHALLENGES**
 - a. How did you handle this situation? **ACTIONS**
 - b. How did the MU graduate program help you to deal with this situation? **PROFESSIONAL DEVELOPMENT**
 - c. What are some other things you could have done? **ACTIONS**
 11. How do you typically spend your time during a workweek (i.e., what percent on instruction? Mathematics curriculum leadership? Other?)?
 12. Can you explain a frustrating situation (related to mathematics) you faced this past year? **CHALLENGES**
 - a. How did you work through this situation? **ACTIONS**
 - b. Who did you talk to about the situation? **ACTIONS**
 - c. Did you use any other resources? **PROFESSIONAL DEVELOPMENT**
 - d. Was the situation resolved? **IEWS**
 13. What are the barriers to improvement in your school and district? **CHALLENGES**
 14. What mathematics curriculum leadership roles do you desire in the future?
 15. What additional mathematics curriculum leadership skills or knowledge do you still need to develop? **PROFESSIONAL DEVELOPMENT**
 16. What are resources/structures needed to support you as a mathematics curriculum leader? **PROFESSIONAL DEVELOPMENT**

MU Graduate Program Experience:

1. Why did you decide to participate in the MU mathematics curriculum leadership graduate program? **PROFESSIONAL DEVELOPMENT**
2. What were your expectations of the MU mathematics curriculum leadership graduate program? **PROFESSIONAL DEVELOPMENT**
3. How did your participation in the MU program influence your views of the mathematics curriculum leadership roles you hold/held? **PROFESSIONAL DEVELOPMENT/IEWS**
4. How did your participation in the MU program influence how you approach mathematics curriculum leadership opportunities? **PROFESSIONAL DEVELOPMENT**

Do you have anything else to share about how the MU program influences your current thinking or leadership work?

APPENDIX D: CONSENT FORMS

E-MAIL RECRUITMENT SCRIPT

While you were enrolled in the Mathematics Curriculum Leadership Graduate Program from 2005-2008, you gave consent to participate in a research study that I conducted. Ms. Liza Cummings, a doctoral student in mathematics education, would like to extend this study and conduct one more interview with you during the Spring 2011 semester. As part of Liza's dissertation, she would like to interview you for about one hour about your leadership opportunities you have had following the completion of the graduate program. These interviews would take place at a location (e.g., your school or the MU campus) and during a time that is convenient for you. As Liza's dissertation advisor, I will oversee her study.

I hope you will be able to participate in the study as I believe that learning about your leadership efforts following the program will provide us with insights into designing future graduate programs and will help us better support mathematics curriculum leaders in the future.

I have attached the consent form. The consent form explains the details of the research study and outlines the commitment of the work if you were to agree to participate.

If you have any questions about the study or if you are willing to participate in the study, please email (lca3d@mail.missouri.edu) or phone (314-420-2856) Liza Cummings or Kathryn Chval at chvalkb@missouri.edu or 573-239-1338.

**UNIVERSITY OF MISSOURI
TEACHER INFORMED CONSENT**

Mathematics Curriculum Leadership Graduate Program: A Follow-Up Study

The purpose of this research study is to identify participants' leadership activities following their graduation from a mathematics curriculum leadership graduate program.

INFORMATION

You must be at least 18 years of age to be eligible to participate in the study. Your participation in this study is voluntary; you may choose not to participate and there will be no penalty. If you decide to participate, you may withdraw from the study at any time without penalty.

PARTICIPATION

Participate in one audio-recorded interview (February 2011) in which you will be asked questions about your leadership roles after you participated in a mathematics curriculum leadership graduate program. I anticipate the interview will last approximately 1 hour. Prior to the interview I will ask you to email me responses to two questions:

1. What leadership role(s) have you assumed following your completion of the mathematics curriculum leadership graduate program?
2. What professional development have you participated in following your completion of the mathematics curriculum leadership graduate program?

Your written responses to these questions will help me better prepare for the interview.

BENEFITS

Your participation in this research study will provide insight into the knowledge needed for teaching mathematics curriculum leaders. The research findings will support other mathematics curriculum leaders who support the teaching and learning of mathematics. The information gained in this study may be useful to designers of teacher education programs and professional development programs in mathematics education. The information gained in this study may be published and may also be useful to mathematics teacher educators at other universities and colleges.

CONFIDENTIALITY

Your identity will be kept strictly confidential. The data collected during the study will be stored in a secure area in Townsend Hall. In reporting the findings of this study, your name will be replaced with a pseudonym. You may choose to end your participation at any time during the study, and your data will be destroyed. Data will

be stored for three (3) years beyond the completion of the study and at that time it will be destroyed.

RISKS This project does not involve any risks greater than those encountered in everyday life. This project has been reviewed and approved by the University of Missouri Human Subject Review Board. The Board believes the research procedures adequately safeguard your privacy, welfare, civil liberties, and rights. For additional information regarding human subject participation in this research, please contact the University of Missouri IRB officer at (573) 882-9585.

CONSENT

Please read the consent statements below. If you have questions, please email or call me. If you do not have any questions, please copy and paste the statements in an email and place an “x” next to the statement that describes your desire to participate in this study. Please send the email to Liza Cummings at lca3d@mail.missouri.edu.

I have read the information presented above and have had an opportunity to ask questions and receive answers pertaining to this project.

_____ I hereby agree to participate in this research study. I am aware that my participation is voluntary and that I am free to withdraw participation at any time without any penalties to myself.

_____ I do **not** agree to participate in this research study.

Name: _____ Date: _____

Thank you. If you have questions at any time, please call Liza Cummings at the University of Missouri at 314-420-2856.

APPENDIX E: CODING DICTIONARY

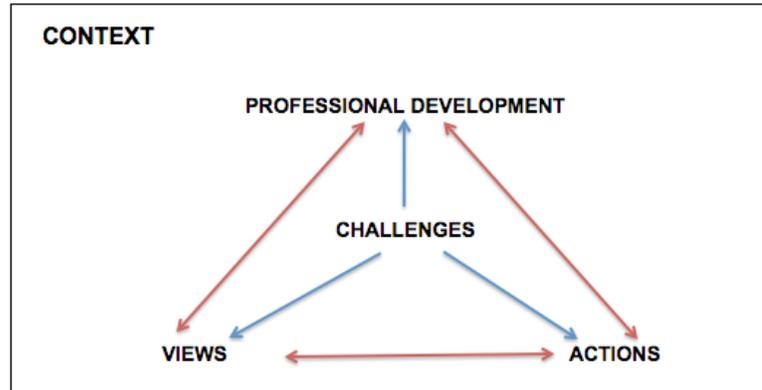


Figure 3. Critical factors that influence the work of mathematics curriculum leaders.

Table 6

Coding Dictionary

Conceptual Framework Components:	Example:
A. The preparation or professional development of curriculum leaders:	Phrases suggesting <i>preparation/PD</i> : <ul style="list-style-type: none"> • <i>I learned...</i> • <i>I read...</i> • <i>I want to learn...</i> • <i>I need to know...</i>
B. The actions of curriculum leaders:	Phrases suggesting <i>actions</i> : <ul style="list-style-type: none"> • <i>I help with...</i> • <i>I helped the teacher...</i> • <i>I did...</i> • <i>I advise...</i> • <i>I create...</i>
C. The views of curriculum leaders' work:	Phrases suggesting <i>views</i> : <ul style="list-style-type: none"> • <i>I want to be viewed as...</i> • <i>It was not one of my jobs...</i> • <i>Leadership is...</i> • <i>My principal thinks leaders should...</i>
D. Challenges encountered by curriculum leaders	
a. Teacher/Curriculum Leaders' Roles and	Phrases suggesting <i>challenges with roles and responsibilities</i> :

Responsibilities are not Established and Explicitly Communicated	<ul style="list-style-type: none"> • <i>I am not sure of...</i>
b. Teacher/Curriculum Leaders Do Not Receive Sufficient Support	Phrases suggesting <i>challenges with support</i> : <ul style="list-style-type: none"> • <i>My principal didn't back me up.</i>
c. Time Constraints	Phrases suggesting <i>challenges with time</i> : <ul style="list-style-type: none"> • <i>I did not have time to...</i>
d. Knowledge	Phrases suggesting <i>knowledge</i> : <ul style="list-style-type: none"> • <i>I don't know how to...</i> • <i>I didn't know what to do...</i>
e. Other Challenges of Teacher/Curriculum Leaders	Phrases suggesting <i>other challenges</i> : <ul style="list-style-type: none"> • <i>Which way is better?</i> • <i>What should I do first?</i>
E. Context	Phrases suggesting <i>context</i> : <ul style="list-style-type: none"> • <i>In our school, teachers...</i> • <i>Changing the curriculum...</i>

VITA

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Liza devoted eleven years with the Saint Louis Public Schools in Saint Louis, Missouri as a secondary mathematics teacher. During doctoral studies, she instructed undergraduate mathematics education courses, facilitating professional development for mathematics teachers, and conducted research in schools. As a graduate research assistant at MU, she was actively involved with collecting and analyzing data for three research studies including two studies that were funded by the National Science Foundation.